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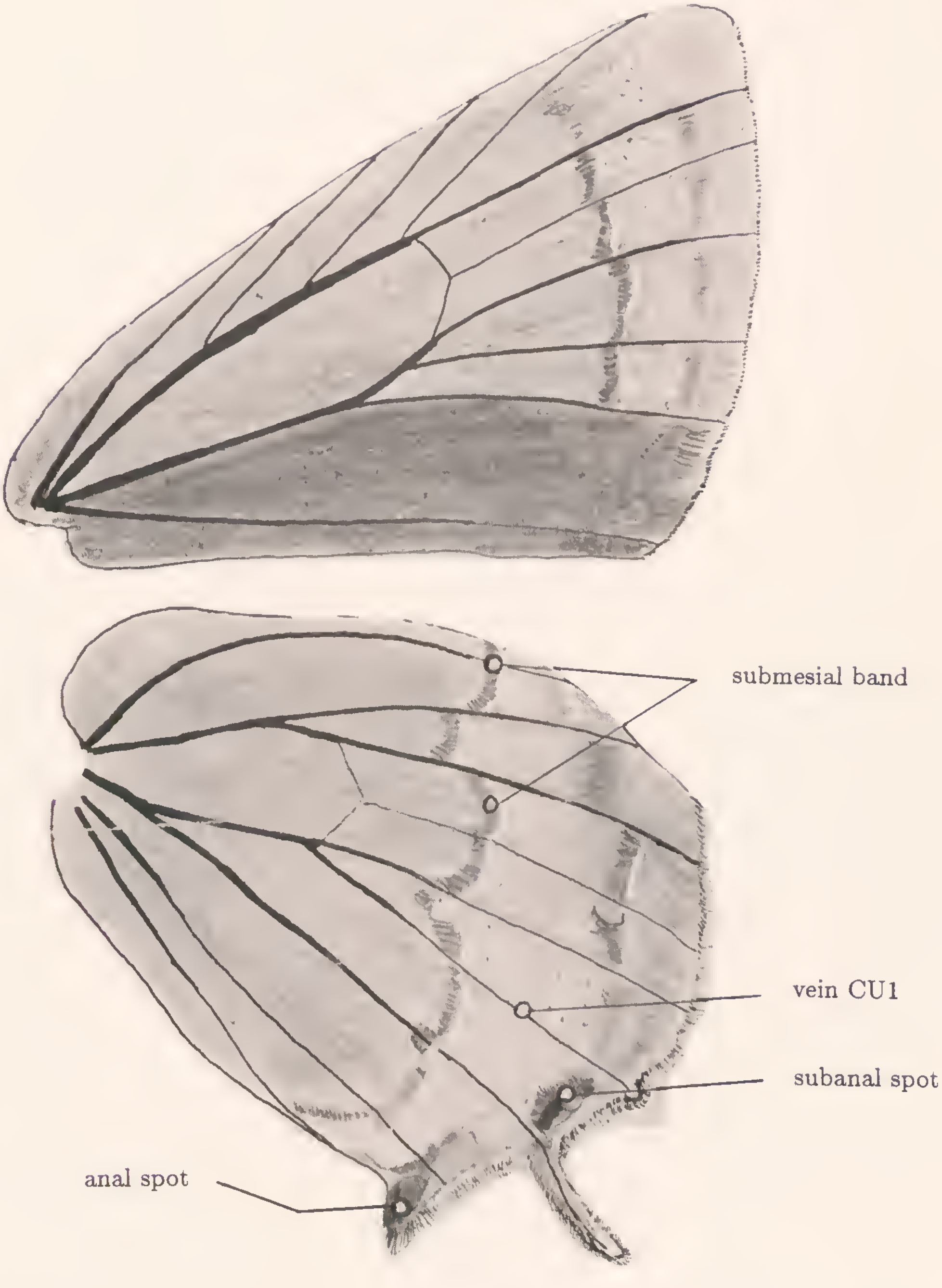

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ATALA

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Articles

Santa Catalina Island's Endemic Lepidoptera
III. The Avalon Hairstreak, *Strymon avalona* (Lycaenidae): An Ecological Study

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Abstract

A 10-year study of the Avalon Hairstreak *Strymon avalona*) is presented, including adult behavior, larval hostplant ecology, phenology, and predators and parasites. Despite the restricted distribution of *S. avalona* and its occasional sympatry with *Strymon melinus* on Santa Catalina Island, this study revealed few threats to either its biological integrity or habitat. Ecological data from other California Channel Islands and several mainland California localities is also included, as are some thoughts on the Avalon Hairstreak's possible evolutionary origin.

Introduction

The Avalon Hairstreak, *Strymon avalona* (Wright) (Figs. 1-3), has one of the most restricted geographic ranges of any North American butterfly (Emmel and Emmel, 1973). First recognized as a new species late in the 19th Century, the butterfly was described as California's first insular endemic by Wright in 1905. Until recently (see Gall, 1985), few comprehensive ecological or behavioral studies had been aimed at explaining (1) its limited distribution, (2) its relationship with the Common Hairstreak, *Strymon melinus* Hubner, or (3) its possible evolutionary origin. In this paper, I present a detailed account of the Avalon Hairstreak's ecology and behavior in a conservational light.

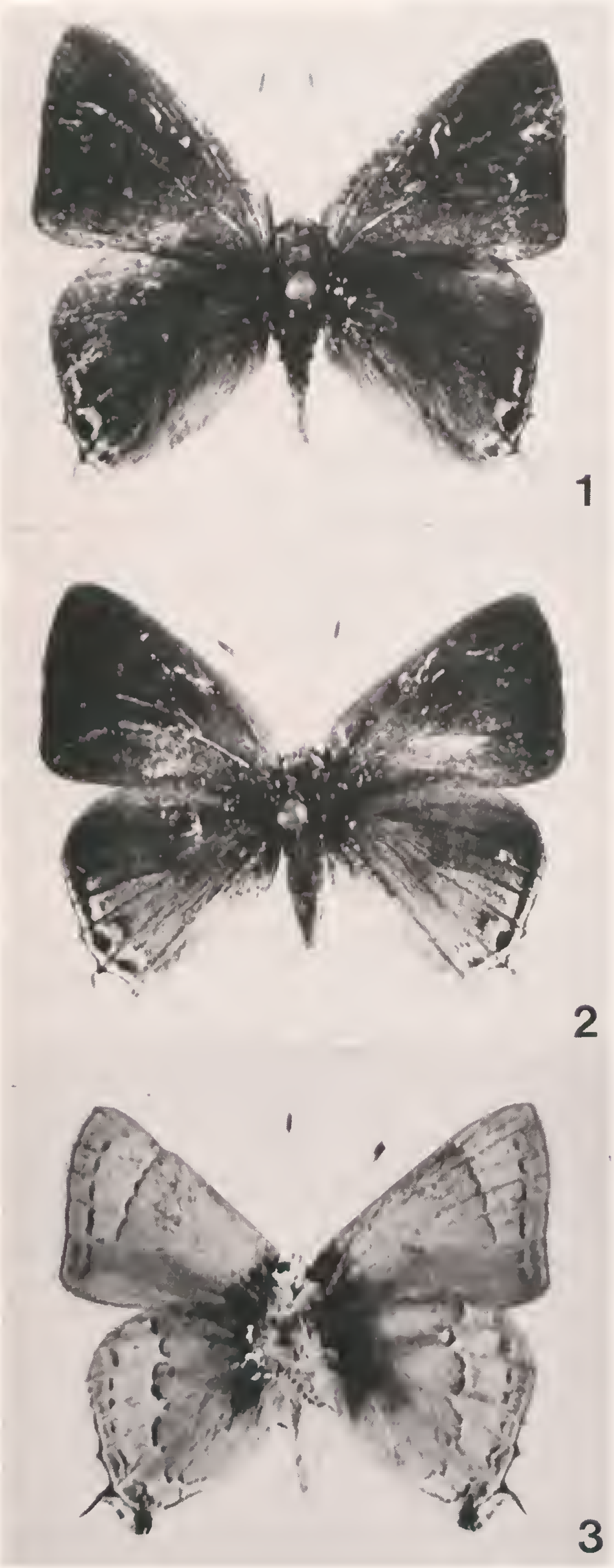
Historical Background

Whereas the scientific literature is replete with works on Santa Catalina Island's unique plants, relatively little has been written on the insects. Miller and Menke (1981) list over 400 references to the general insect life of the California Islands, including Santa Catalina Island, but only Thorne (1970) and Gall (1985) have written specifically on the Avalon Hairstreak since the 1930s. Coolidge (1923) described the egg of *S. avalona*, and oviposition by females on *Syrmatium* (now called *Lotus*, and Comstock and Dammers (1933) followed with a thorough treatment of the entire life history. Meadows (1937) produced an annotated list of the Lepidoptera of Santa Catalina Island including the Avalon Hairstreak and a brief paragraph regarding its occurrence near Avalon.

Later, Cockerell (1939), Thorne (1970), Remington (1971), Orsak (1975), and Gall (1977, 1979) published accounts of collecting trips to the island, which listed *Strymon avalona*. Miller (1984) also discusses the Avalon Hairstreak within his survey of the butterflies of the California Channel Islands. Most recently, Gall (1985) published a primarily morphometric study addressing the biological implications of the Common Hairstreak's appearance on Santa Catalina Island, a topic overlapping my own studies on the closely related *S. avalona*.

Island Geography, Climate and Phenology

Santa Catalina Island, a continental island, is 34 km long and 13 km wide at its widest point (Long Point). A part of Los Angeles County, Santa Catalina Island is sit-



Figures 1-3. The Avalon Hairstreak, *Strymon avalona* (Wright). Male dorsal surface (Fig. 1), female dorsal surface (Fig. 2), and male ventral surface (Fig. 3). All specimens taken at Catalina Harbor, Santa Catalina Island, May 1974.

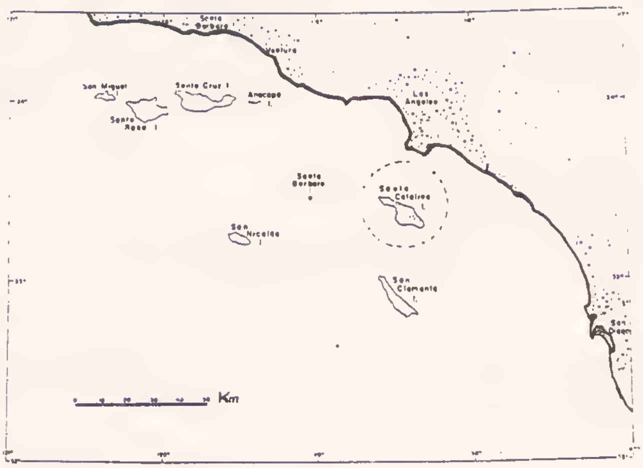


Figure 4. The California Channel Islands.

	RAINFALL cm								AVERAGE ANNUAL TEMPERATURE °C	
YEAR	JAN		FEB		MAR		ANNUAL			
1974	12.52	(4.93)	0.61	(0.24)	6.76	(2.66)	36.98	(14.56)	19.1°	(66.3°)
1975	0.10	(0.04)	6.68	(2.63)	9.17	(3.65)	24.71	(9.73)	19.0°	(66.1°)
1976	0.00	(0.00)	7.59	(2.99)	3.96	(1.56)	23.47	(9.24)	17.0°	(62.8°)
1977	4.85	(1.91)	0.03	(0.01)	2.92	(1.15)	32.03	(12.61)	17.5°	(63.5°)
1978	18.29	(7.20)	18.19	(7.16)	18.92	(7.45)	75.03	(29.54)	17.8°	(64.1°)
1979	9.70	(3.82)	4.52	(1.78)	5.66	(2.23)	21.03	(28.28)	17.6°	(63.7°)
1980	16.66	(6.56)	19.81	(7.80)	6.76	(2.66)	48.26	(19.00)	17.8°	(64.1°)
1981	3.96	(1.56)	3.30	(1.30)	8.92	(3.51)	75.79	(29.84)	20.0°	(68.2°)
1982	11.33	(4.46)	3.25	(1.28)	8.00	(3.15)	32.79	(12.91)		

Figure 5. Climatological data for 1974-1982, taken at the Avalon Pleasure Pier, Santa Catalina Island (inches and degrees fahrenheit in parentheses).

uated in the Pacific Ocean at about 33 degrees N and 118 degrees W, approximately 32 km south from Pt. Vicente on the Palos Verdes Peninsula (Fig. 4). It is composed of metamorphic rock partly covered by lava flows (Van Balgooy, 1969). The exploration and historical changes affecting the topography and vegetation of the island are discussed in great detail by Gregg (1934), Thorne (1967), and Minnich (1980). Avalon, the principal city with a resident population of some 1530, is located on the southeast end of the island. In 1975, the Santa Catalina Island Conservancy, a non-profit foundation, acquired title to approximately 42,135 acres, roughly 86% of the island's 197 square kilometers.

Santa Catalina Island has the warmest temperatures of all eight Channel Islands, with an average annual temperature of 16 degrees C (Van Balgooy, 1969). Be-

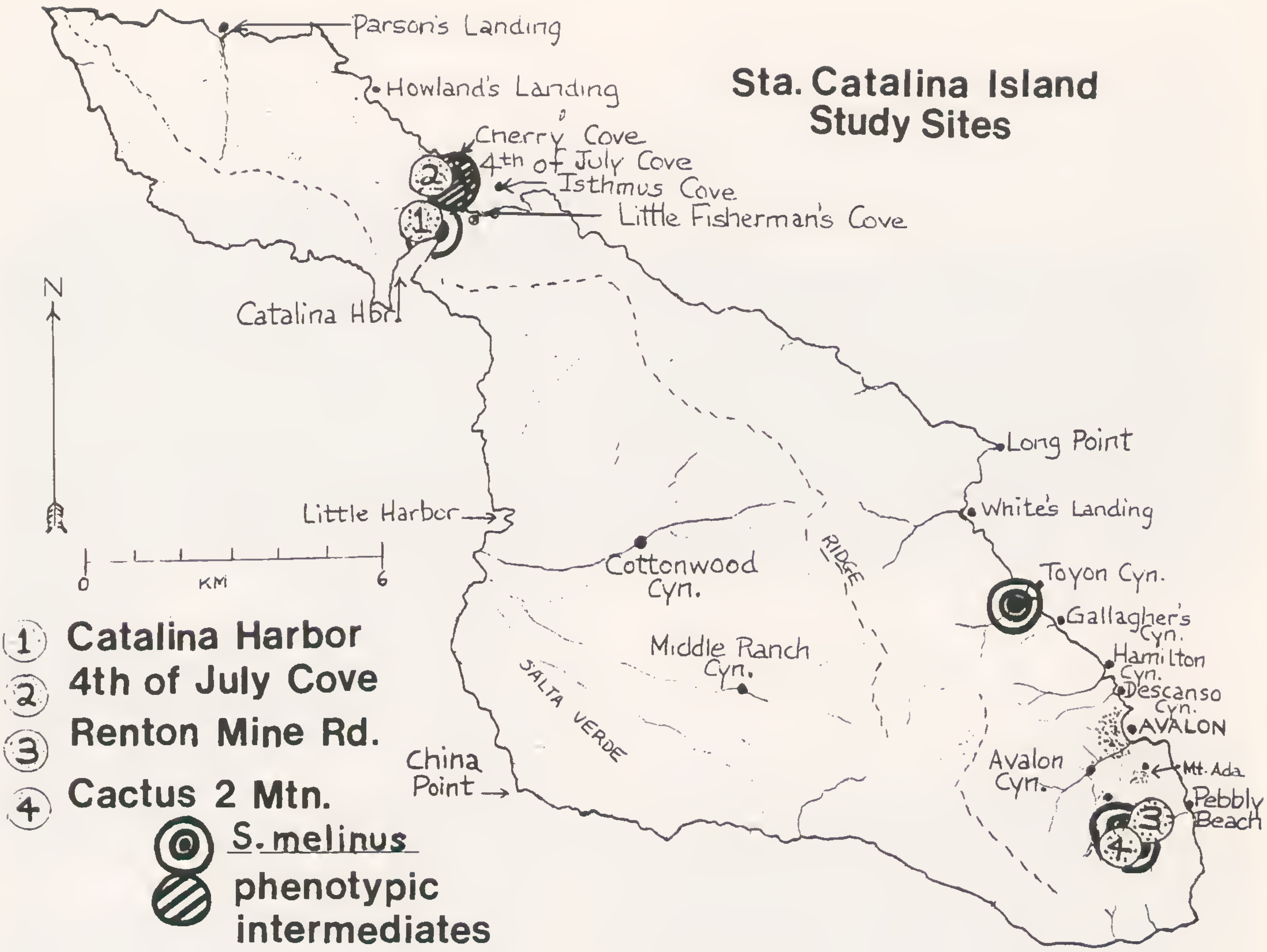
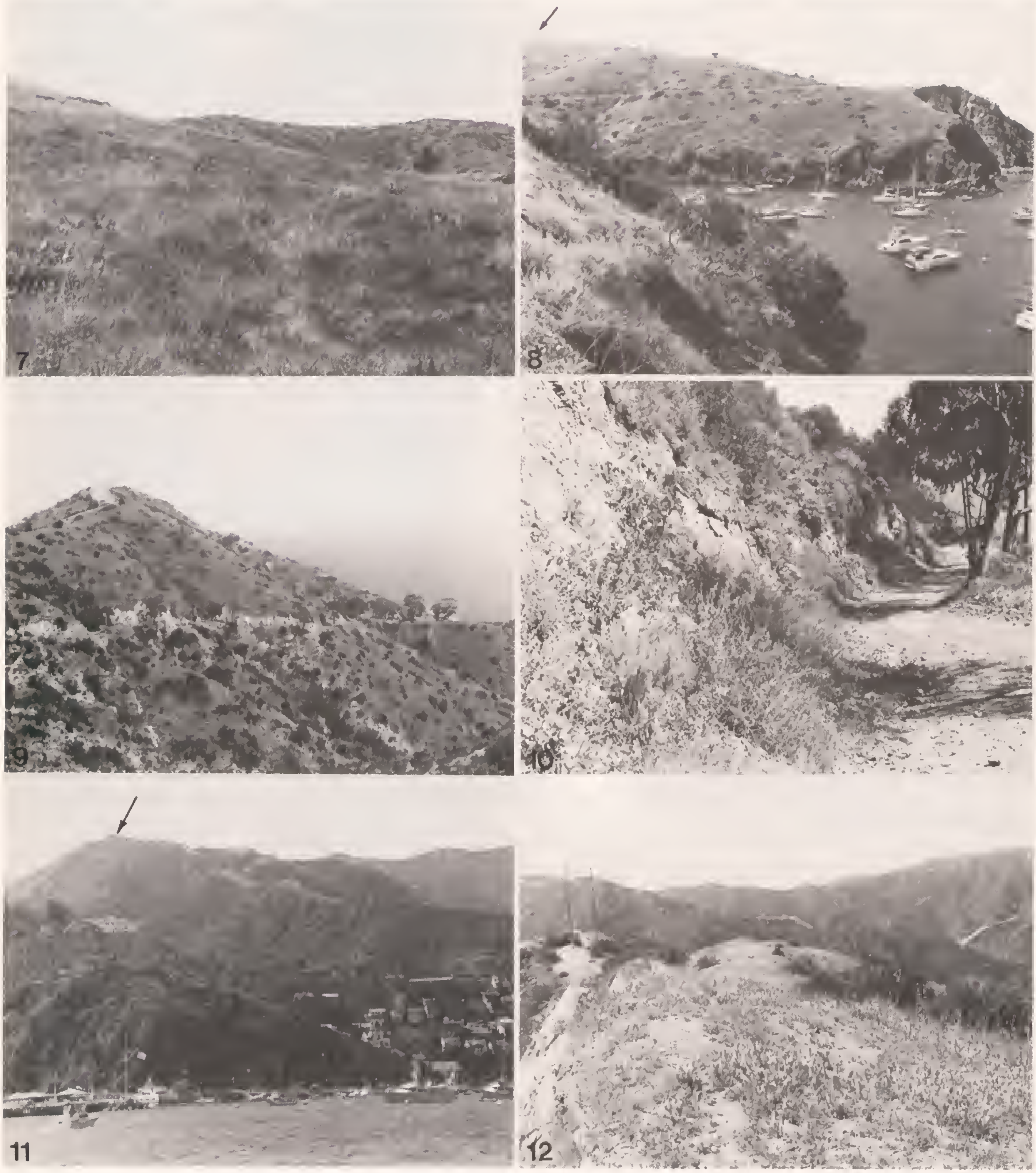


Figure 6. Map of Santa Catalina Island, showing primary *Strymon avalona* study sites for this research, localities of recent captures of *Strymon melinus* and probable hybrids between the two taxa (see text, and Gall [1985] for discussion of interspecific interactions).

tween 1974 and 1982, I recorded average temperatures of 17-18 degrees C. Daily weather data are accumulated at the Avalon Pleasure Pier at the southeast end of the island, 7.6 m elevation, and entered monthly into the Annual Climatological Data Summary published by the National Oceanic and Atmospheric Administration (NOAA). The climatic data compiled between 1974 and 1982 utilized the readings from this station. In 1978, an additional weather station at Two Harbors was monitored by students under the direction of the Catalina Island Museum in Avalon. The data for both stations suggest a fairly uniform temperature range for both the northeast and southeast ends of the island.

Dunkle (1950) described Santa Catalina Island as an arid maritime zone with 15-34 cm of annual rainfall, the drying effect of the easterly Santa Ana winds from the mainland seem to contribute to an ecological "dry date" that precedes that of the mainland by at least four weeks. Defined as the date on which evapotranspiration from soil and plant life equals or exceeds the total precipitation to that date, Weissman and Rentz (1977) indicated that this occurs typically during the first week of May on Santa Catalina Island.

Strong westerly winds from the Pacific Ocean tend to influence the distribution and abundance of the plants chosen by Avalon Hairstreak females. The large breeding colonies were only encountered in relatively sheltered canyons and along the south- facing slopes or the leeward or eastern exposure of the island Other localities were apparently too windy. Suitably exposed habitats for the Avalon Hairstreak were found in sections of both Descanso and Gallagher's Canyons, yet no large breeding



Figures 7-12. Four primary study sites for this research. Site 1 (Fig. 7): south facing slopes above Catalina Harbor. Site 2 (Fig. 8): ridge above Fourth of July Cove, 3km NW of isthmus. Site 3 (Figs. 9-10): Renton Mine road, 1.5 km SE of Avalon. Site 4 (Figs. 11-12): Cactus 2 Mountain, 0.5 km SE of Avalon. See text for elaboration.

colonies were found. The absence of *Lotus* and abundant *Eriogonum* in these canyons may well have been caused by crowding and allelochemic interaction with dominant black sage, *Salvia mellifera* Greene growth (Muller and Muller, 1964; Muller, 1965).

In 1976, peak adult numbers were observed in all four study sites in March, whereas in most other years during the study, peak counts were made in May. Gall (1977) reported sightings of more than 1000 individuals on the southeast end of the island near Avalon between March 24-26, 1976, and I saw similar numbers on the west end of Santa Catalina Island in May of that year. No similar population explosions have been seen since 1976, despite normal hostplant availability and a lack of any major temperature fluctuations in any given season.

Description of Study Sites

Data pertaining to the biology and ecology of the Avalon Hairstreak were gathered from 1974 and 1983 at four study sites on the island (Fig. 6). Two study sites of approximately 4,180 sq m each were established in 1974 near Two Harbors: (1) a south-facing slope south of the Isthmus above Catalina Harbor at l5-30 m elevation (Study Site 1); and (2) a ridge with a firebreak above 4th of July Cove, approximately three km northwest of the Isthmus, at 122-152 m elevation (Study Site 2) (Figs. 7-12).

During a three-day visit to the Two Harbors area in May 1974 and May 1975, I made observations of adult courtship, mating, oviposition, and larval abundance. Three- to five-day visits were made to the study sites in July and September 1977, as well as in March, May, July, and August 1978. These later visits focused primarily on adult territoriality. Between 1979 and 1984, two-day visits were made each March and April that concentrated on hostplant ecology and searches for *Strymon melinus*. Both stud y sites have reddish soil, and the well-weathered colluvial sloopes consist of quartz, dioritic bedrock (fine grain) and a powdery clay soil rich with iron and other minerals.

In 1978, two additional study sites were established near Avalon. Study Site 3 included the Renton Mine Road between 0.8-1.6 km SE of Avalon at an elevation of 112-115 m. Study Site 4 included a steep ridge marked by telephone lines along a firebreak leading to the summit of Cactus 2 Mountain. The summit overlooks the Wrigley Mansion and the city of Avalon, at an elevation of approximately 275 m (Figs. 7-12).

The vegetation typical of the slopes in all four study sites is Coastal Sage Scrub (Thorne, 1967) and includes as dominant shrubs and herbs: *Rhus integrifolia* (Nutt.) Benth. and Hook. ex. Rothr., *Adenostoma fasciculatum* H. and A., *Lotus argophyllus* (Greene) ssp. *ornithopus* Ottley, *Artemisia californica* Less., *Eriogonum giganteum* S. Wats. ssp. *giganteum*, and *Opuntia* sp.

Adult Behavior

The Avalon Hairstreak frequents the ridgetops, firebreaks, and the dry, rocky, south-facing slopes which are widely distributed on the island. Adults flew from mid-February to early October (Fig. 13), although Meadows (1937) noted their presence on the island every month of the year. At least six overlapping broods may occur in one year, since *S. avalona* averages 34 days to complete its life cycle at room temperature between March and June (lab rearings on *Lotus* and *Eriogonum*).

While most mornings were foggy with westerly breezes during midday, sunny conditions with temperatures between 21 and 24 C typically prevailed. Flight activities at Study Site 1 were observed shortly after 0915 PDT some mornings, lasting until around 1800 PDT. Ridges and upper slopes, characterized by both *Rhus integrifolia* and *Opuntia* sp., were favorite haunts for males, with each *Rhus* stand having one or two outward-facing males perched on the leaves of the lowest branches. In the mornings, both males and females frequented the flowers of *Hemizonia clementina* Brandeg., a yellow composite, and those of the principal larval hostplant, silvery clover (*Lotus argophyllus* ssp. *ornithopus*). Adult nectar sources were nearly the same in each of the four study sites, but these sources changed seasonally with the availability of flowers (Fig. 14). Numerous ovipositions were observed in Study Site 1 between 1100 and 1300 PDT; the females preferred unopened flower buds or young terminal leaves as substrates. For the most part, only one or two eggs were laid on any given *Lotus* stem; occasional eggs were found on lower leaves.

Courtship and mating took place in the afternoons. Male Avalon Hairstreaks aggressively pursued females downslope, with courtship and mating occurring either on *Artemisia* or *Lotus*. Eleven matings on *Artemisia* and *Lotus* stands were observed between 1500-1700 PDT, although examination of the abundant *Rhus integrifolia* growing along the same ridges and upper slopes revealed no mating pairs. Pairs remained *in copulo* for 30-60 minutes, with both sexes remaining on the plant after separating. Since no further flights were observed after 1800 PDT, it seems likely that adults pass the night at the base of the woody *Artemisia* or *Lotus* plants at Site 1.

In 1977, marking studies and detailed observations were made to study male territoriality. Three females and eleven males collected on *Eriogonum giganteum* were marked in Study Site 2 with a single blue dot of oil-based paint on the hindwing underside on July 2, 1977. None of these was recaptured the following day among captures of 21 males and 11 females. Ten other males were captured on July 2, marked with a red dot as above, and then released on *Rhus* shrubs overlooking 4th of July Cove; 18 of 23 shrubs were occupied by a single male Avalon Hairstreak. A return to the site on July 3 yielded no marked specimens, yet other males occupied the row of *Rhus* shrubs, mostly one per plant. On occasion, a second male perched facing outward on the opposite side of the same stands, out of the visual range of the first. Numerous territorial displays as described in other hairstreak species (Shields, 1967; Gorelick, 1971) between competing males were seen in Study Site 2 during the afternoon hours.

On September 2, another seven fresh and one worn male were marked and released. The following day, only one fresh specimen was recaptured approximately 30 m uphill. A total of 13 additional *S. avalona* were captured and 15 others sighted between 3-4 September in Study Site 2.

Whereas territoriality displays were evident in all four study sites, the marking studies suggest that occupation of these shrub territories lasts no more than four to six hours, and/or that mark intensity was simply not high enough in the studied populations. Sex ratio counts heavily favored males when sampling was done throughout any given year on ridge summits, approaching 10:1

per sample of 20 specimens. When a random sample of 20 specimens was taken along the roadside near nectar sources or hostplant concentrations, the ratio dropped to 2:1.

Immature Stages

Field work begun in 1978 was expanded to include mass rearing of eggs and larvae. In Study Sites 1 and 3, many eggs and differing instar larvae of *Strymon avalona* were taken on *Lotus argophyllus* ssp. *ornithopus* (Fig. 15). This plant is characterized by stems with many inflorescences along the entire length; larval samples were collected, an average of 3 larvae per plant.

Many of these larvae were transferred to different, selected laboratory hosts to assess foodplant preferences and suitability. Successful laboratory rearings from young larvae to adults were obtained using young leaves, flower buds, and flowers of *Wisteria* sp., *Hibiscus* sp., *Malva parviflora* L., *Eriogonum fasciculatum* Benth., and a common introduced ground cover, *Polygonum capitatum*. Feeding damage was evident on the leaves in the form of skeletonization. In captivity, Avalon Hairstreak larvae, like those of the Common Hairstreak, were found to be cannibalistic; when three or more were confined together in large mason jars with screen lids, only one would remain after several days.

On March 2, 1978, two mature *S. avalona* larvae were found in Study Site 3 on deerweed, *Lotus scoparius* (Nutt. in T. and G.) Ottley ssp. *dendroideus* (Greene) Ottley growing in proximity to the shorter but more abundant stands of *Lotus argophyllus* (Fig. 16). As the spring progressed, larger numbers of Avalon Hairstreak eggs and larvae were found almost exclusively on the maturing *Lotus argophyllus* buds. In that no further *S. avalona* larval discoveries were made on *Lotus scoparius* after March, it is undoubtedly only a secondary host.

Also abundant in Study Sites 3 and 4 were stands of *Eriogonum giganteum* ssp. *giganteum* which, like the two *Lotus* species, is endemic to the California Channel Islands (Dunkle, 1950; Thorne, 1967). This plant is also well distributed along the Renton Mine Road and in Avalon, Hamilton, Gallagher's, and Middle Ranch Canyons (Fig. 17). Adults commonly took shelter in the broad, pilose leaves on windy days. In June, when the inflorescences first appear on stands of *Eriogonum giganteum*, *S. avalona* females switch from the now-desiccated *Lotus argophyllus* buds and flowers to *Eriogonum* both for nectaring and oviposition. Single eggs were found on the calyx of both opened and unopened flowers. A fourth hostplant, *Eriogonum grande* ssp. *grande* Greene, was discovered in July 1978 at Little Fisherman's Cove near the Isthmus. Here, eggs were also found on the floral calyx, one per flower. Like the other hosts, this plant colonizes dry, rocky south-facing slopes and can be seen scattered about at Pebbly Beach, the mouths of Hamilton and Gallagher's Canyons, White's Landing, Parson's Landing, and along the rocky roadside embankments above Two Harbors (Fig. 18).

Larval samples taken from *Eriogonum* during the summer were much lower in numbers than those taken from *Lotus* during the spring. Only 0-2 larvae were taken on each of the roadside *Eriogonum giganteum* shrubs between the Isthmus and 4th of July Cove.

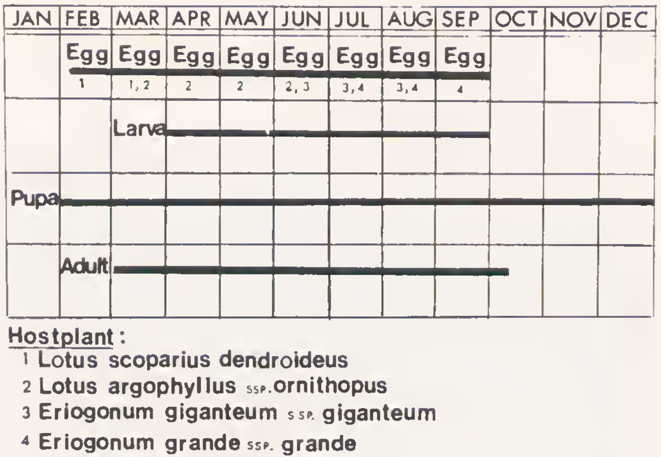


Figure 13. Life history of *Strymon avalona*.

PRINCIPAL ADULT NECTAR SOURCES
Strymon avalona (Wright)

MARCH - MAY:

Lotus argophyllus ssp. *ornithopus*
Hemizonia clementina
Salvia mellifera
Encelia californica

JUNE - AUGUST:

Eriogonum giganteum ssp. *giganteum*
Eriogonum grande ssp. *grande*
Heteromeles arbutifolia
Hemizonia clementina
Salvia mellifera
Rhus laurina

SEPTEMBER - OCTOBER:

Eriogonum giganteum ssp. *giganteum*

Figure 14. Adult nectar sources of *Strymon avalona*.

Figures 15-18. Larval foodplants of *Strymon avalona*. Primary host, Silvery Clover, *Lotus argophyllus* ssp. *ornithopus* at Study Site 1 (Fig. 15); larva feeding on *Lotus scoparius* ssp. *dendroideus* in lab (Fig. 16); *Eriogonum giganteum* ssp. *giganteum* at Study Site 3 (Fig. 17); *Eriogonum grande* ssp. *grande* near Study Site 2 (Fig. 18). See text for elaboration.

HYMENOPTEROUS PARASITOIDS OF *STRYMON*
SPECIES ON SANTA CATALINA AND *SANTA* CRUZ
ISLANDS

HOST SPECIES	STAGE	PARASITOID	# OF EMERGENCES	DATE	HOST SUBSTRATE	SPECIFIC LOCALITY
1	larva	*Perilampus fulvicornis* Ashmead	3	Aug 1978	*Eriogonum gigantaum*	vicinity of Pebbly Beach
1	larva	*Apanteles theclae* (Riley)	100	Aug 1978	*Eriogonum giganteum*	vicinity of Pebbly Beach
1	**	*Mesochorus* sp.	12	Jun 1978	*Eriogonum giganteum*	Study Site 3
1	larva	*Anisobas* sp.	2	Mar 1978	*Lotus scoparius*	Study Site 3
1	larva	*Aplomya theclarum* (Scudder) *	1	Mar 1978	*Lotus argophyllus*	Study Site 3
2	larva	*Apanteles theclae* (Riley)	200	Jun 1978	*Lotus scoparius*	Upper Sauces Cyn.
2	**	*Mesochorus* sp.	3	Jun 1978	*Lotus scoparius*	Upper Sauces Cyn.

* tachinid fly
** hyperparasitic on *Apanteles theclae* larvae

1 *Strymon avalona* (Wright)
Santa Catalina Island, Calif.

2 *Strymon melinus* (Hbn.)
Santa Cruz Island, Calif.

Figure 19. Parasitoid records for *Strymon avalona*, and *Strymon melinus* (on Santa Cruz Island).

Predators and Parasites

During the study, predation and parasitism of Avalon Hairstreaks were encountered. In Study Site 1, three specimens collected between 1976 and 1978 had forewing chips suggestive of attack(s) by birds. In May of 1980 and 1983, several species of hunting spiders (one a jumping spider, Family Salticidae) captured larvae that were feeding on leaves or flowers of *Lotus argophyllus* at Catalina Harbor. Also noteworthy were the abundant webs spun between adjacent *Opuntia* stems by orb-weaving spiders (Family Araneidae), yet they seemed to capture primarily grasshoppers; one worn Avalon Hairstreak adult was taken from such a web in Study Site 1 in May 1983.

In many instances, samples of *Strymon avalona* larvae collected on Catalina Island were found to be parasitized by wasps. Many of the emergent parasitoid species were identical to those reared from the Common Hairstreak larvae collected on Santa Cruz Island (Fig. 19). On Santa Catalina Island during the summer months, when *Eriogonum giganteum* and *E. grande* are chosen as hostplants, many larvae taken from the latter were heavily parasitized. In 1978, 9 of 12 larvae (75%) collected in Study Site 3 on terminal inflorescences succumbed. Few parasites were shed by larvae taken from all four study sites during the spring months, yet many were obtained between June and August from larvae among stands of *Eriogonum giganteum* growing along the road in the vicinity of Study Sites 2 and 3. This may explain why comparatively large numbers of *Strymon avalona* have been reported during the spring by collectors, whereas later broods are characterized by relatively small numbers. Parasitism may also better explain abundance patterns on a year to year basis.

Larval Interactions

Ecologically, the Avalon Hairstreak occupies a niche rather similar to that of the Common Hairstreak. Both are multivoltine, polyphagous species that exhibit compatable behavior patterns, especially territoriality and mating, as documented for *S. melinus* by Shields (1967) and Scott (1975a). My own host utilization studies on seven of the eight Channel Islands (Fig. 20) revealed that both species do choose many of the same hosts, although throughout its much wider range, *S. melinus* is known to accept many more plant species; at least 46 genera of plants in 21 families are mentioned by Scott (1975a). A more detailed study of immature taxonomy and foodplant use of these two species will be presented elsewhere.

Large numbers of multi-brooded *Plebejus acmon* (Westwood and Hewitson), the Acmon Blue, were also seen in association with *Lotus argophyllus* between June and August during the study. *P. acmon* also utilizes *Eriogonum* species as hosts, although no larvae were taken on *Eriogonum* on any of the Channel Islands during the study (Gorelick, 1969). Field work at San Nicolas Island in June 1978 revealed eggs and larvae of both *P. acmon* and *S. melinus* in abundance on the buds and flowers of *Lotus argophyllus* ssp. *ornithopus* at both Tender Beach and the vicinity of Dutch Harbor on the south side of the island. The same species were taken as larvae on *Lotus argophyllus* ssp. *niveus* one month later near the University of California field station on Santa Cruz Island. Subsequent searches of *Lotus argophyllus decorus* stands at several localities in the San Gabriel Mountains of Los Angeles County (Barrett-Stoddard Canyon, on the Baldy Road below Mt. Baldy, 450-600 m; Crystal Lake, above Azusa on Hwy. 39, 1500-1600 m) revealed eggs, larvae, and adults of both species but in smaller numbers than those found on San Nicolas and Santa Cruz Islands.

On Santa Catalina Island, near Pebbly Beach, larvae of *S. avalona*, *Celastrina ladon* (Cramer), and *Leptotes marina* (Reakirt) were taken on *Lotus scoparius dendroideus*, another insular endemic, and reared to the adult stage. While these taxa are polyphagous and multivoltine, none was encountered in large numbers, as none seems to select this plant as the principal host on the island. *Plebejus acmon*, not recorded by Meadows for Santa Catalina Island, now occurs sparingly along the road near Airport-in-the-Sky and near the sewage treatment facility at Pebbly Beach. At both sites, it oviposits on *Lotus purshianus*, not a larval hostplant of the Avalon Hairstreak. Repeated collecting and rearing of young stages each year from all four study sites between March and June has failed to turn up the Common Hairstreak. Searches for eggs and larvae in the buds and flowers of introduced *Hibiscus* varieties, *Lavatera assurgentifolia* Kell., and weedy *Malva parviflora* L. growing in Avalon (all documented malvaceous *S. melinus* hosts), failed equally in revealing its presence. In addition. periodic inspections of incoming nursery stock in Avalon revealed no larval damage. It therefore appears that *Strymon melinus* has not yet become permanently established on Santa Catalina Island.

As expected, the comparative studies done on the other Channel Islands and additional collecting trips on the mainland in Los Angeles, Orange, and San Diego Counties failed to turn up the Avalon Hairstreak. *S. melinus* was found frequently in these areas.

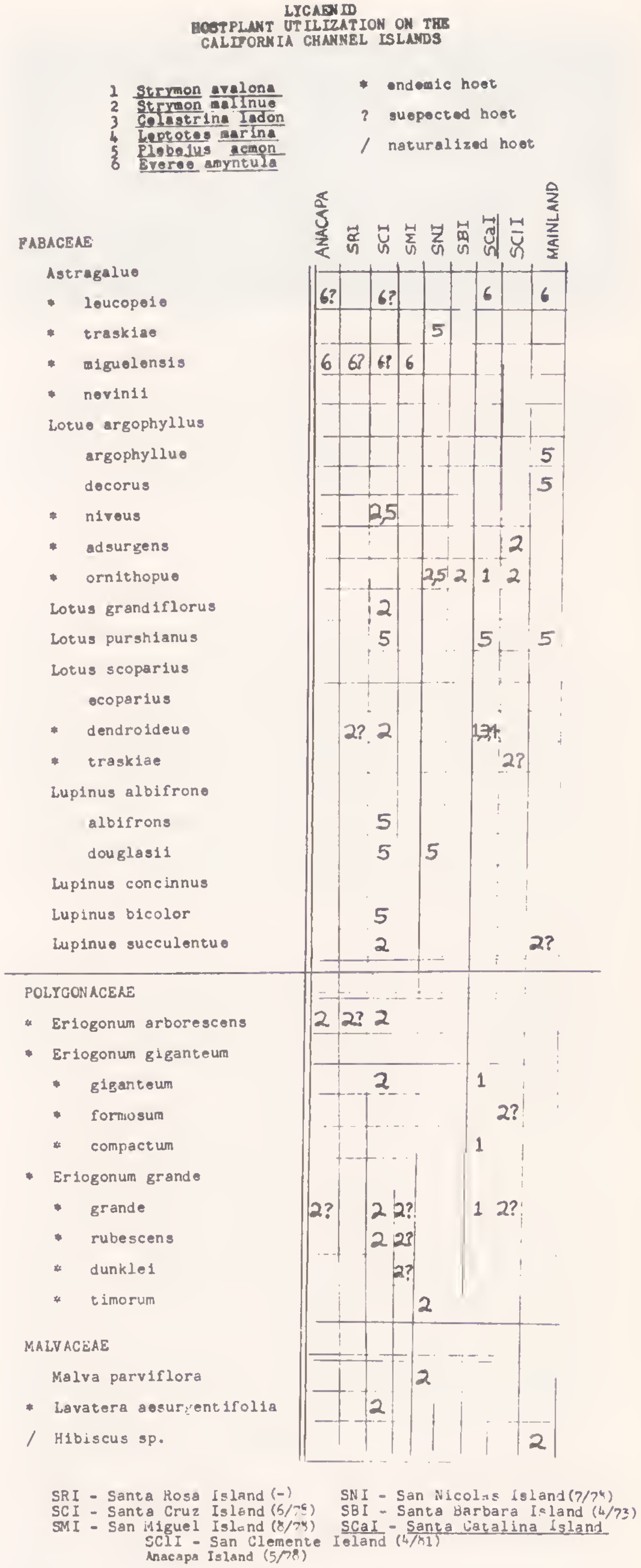
Evolutionary Considerations

Santa Catalina Island, continental in origin, was largely submerged during the Pleistocene (Van Balgooy, 1969). Vedder and Howell (1980), however, point out the existence of some exposed sediments with marine fossil assemblages as early as the late Miocene. The exact timing of Quaternary uplift on Santa Catalina Island is unknown and may be impossible to determine. No evidence as yet exists to suggest that Santa Catalina was connected to any other island or to the mainland (Rowland, 1984).

Remington (1971) and Pyle (1976) considered the Avalon Hairstreak to be a relictual species that was possibly resident on the mainland, perhaps having since been displaced competitively by *S. melinus* (see Fig. 21). The Avalon Hairstreak may be Recent in origin, having evolved in a warm climate that continues today to be characteristic of Santa Catalina Island. Climate, exposure, and a relatively early ecological dry date contribute to rapid, successive, overlapping broods that remain isolated in an insular environment. These conditions also undoubtedly influenced the endemism and speciation of a few species of grasshoppers (Order Orthoptera) on the southern group of Channel Islands discussed by Weissman and Rentz (1976). The endemism of the Avalon Hairstreak on Santa Catalina Island, however, may be autochthonous, that is, a result of small, successive genetic changes that have occurred in isolation on the island. A few ancestral *Strymon* may have arrived on the island by over-water dispersal, postulated to exist widely in the genus *Strymon* (Ehrlich and Ehrlich, 1961).

From approximately five fresh, live male Avalon Hairstreak specimens mailed to Thomas Emmel in May and June, 1979, one successful chromosome squash revealed a haploid number of 22 chromosomes in numerous cells of the male testes. Using the squash technique (Emmel. 1968), this total contrasted sharply with the haploid count of 24 found in *Strymon melinus*, a total discovered by Maeki and Remington (1960) using numerous cells in the testes of three males.

Remington (1971) and Gall (1985) have previously discussed the evolutionary implications of sympatry between these two hairstreaks. With the new chromosomal information, assuming that these two species have differing chromosome numbers, it now appears unlikely that successful genetic interchanges are likely to occur. Interspecific matings, if they occur at all, would produce offspring with little or no ability to backcross. Mating frequency and mate selection are therefore the important limiting factors that govern biological success of either species on the island.



LYCAENID
HOSTPLANT UTILIZATION ON THE
CALIFORNIA CHANNEL ISLANDS

1 Strymon avalona
2 Strymon melinus
3 Celastrina ladon
4 Leptotes marina
5 Plebejus acmon
6 Everes amyntula

* endemic host
? suspected host
/ naturalized host

	ANACAPA	SRI	SCI	SMI	SNI	SBI	SCaI	SCII	MAINLAND
FABACEAE									
Astragalus									
* leucopsis	6?		6?				6		6
* traskiae					5				
* miguelensis	6	6?	6?	6					
* nevinii									
Lotus argophyllus									
argophyllus									5
decorus									5
* niveus			2,5						
* adsurgens								2	
* ornithopus					2,5	2	1	2	
Lotus grandiflorus			2						
Lotus purshianus			5				5		5
Lotus scoparius									
scoparius									
* dendroideus		2?	2				1,3,4		
* traskiae								2?	
Lupinus albifrons									
albifrons			5						
douglasii			5		5				
Lupinus concinnus									
Lupinus bicolor			5						
Lupinus succulentus			2						2?
POLYGONACEAE									
* Eriogonum arborescens	2	2?	2						
* Eriogonum giganteum									
* giganteum			2				1		
* formosum								2?	
* compactum							1		
* Eriogonum grande									
* grande	2?		2	2?			1	2?	
* rubescens			2	2?					
* dunklei				2?					
* timorum					2				
MALVACEAE									
Malva parviflora					2				
* Lavatera assurgentiflora			2						
/ Hibiscus sp.									2

SRI - Santa Rosa Island (-)
SCI - Santa Cruz Island (6/79)
SMI - San Miguel Island (8/78)
SNI - San Nicolas Island (7/79)
SBI - Santa Barbara Island (4/73)
SCaI - Santa Catalina Island
SCII - San Clemente Island (4/81)
Anacapa Island (5/78)

Figure 20. Lyceanid larval hostplant utilization on the California Channel Islands.

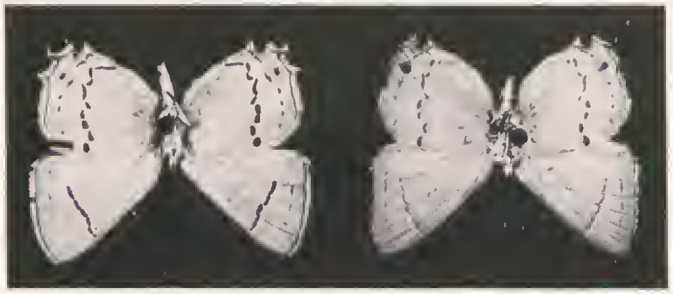


Figure 21. Left: ventral surface of male Avalon Hairstreak, *Strymon avalona* (taken above Cherry Cove, 27 May 1979, Santa Catalina Island). Right: ventral surface of female Gray Hairstreak, *Strymon melinus* (taken above Chinese Harbor, 27 June 1978, Santa Cruz Island).

The few Common Hairstreaks captured on the island between 1978 and 1982 may be the result of overwater dispersal by Santa Ana winds or accidental introductions by daily passenger boat and aircraft services. Alternately, *S. melinus*, being highly polyphagous, may actually exist in very low numbers on the island since it is unlikely to be completely displaced by *S. avalona*. The larvae of the former may use introduced, sparsely distributed hostplants in marginal habitats. Whether competitive displacement actually occurs cannnot be stated on the basis of available evidence, however.

Conclusions

The Avalon Hairstreak appears secure on Santa Catalina Island. The continual well-being of *S. avalona* is dependent upon survival and spread of the native hostplants discussed earlier. Events such as foraging by feral goats (Coblentz, 1977) and road and firebreak construction have aided in the increasing establishment of new stands of *Lotus* and *Eriogonum* on the island. Numerous fires, coupled with rainfall/erosion cycles, also seem to have assisted rather than hindered the spread of these hostplants. Miller (1979) mentions past uses of fire to allow some native hosts to re-establish themselves in larger numbers. Cox and Cox (1977), in their study on successional islands, and Hanes' (1971) discussion on the effect of fire on *Eriogonum* seed germination both document the colonizing ability of *Lotus* and *Eriogonum* in disturbed areas.

Owing to the island's relative inaccessibility, Comstock (1927) referred to the Avalon Hairstreak as "rare". Increasing tourism and daily passenger service have markedly increased the island's accessibility. Human activities, however, seem to have indirectly aided in the Avalon Hairstreak's population growth and spread on the island. At present, continuing urban development and construction projects on the island do not appear to be threatening the well-being of this species.

Acknowledgements

I would especially like to thank E. Douglas Propst of the Santa Catalina Island Conservancy for permission to conduct this study. Also greatly appreciated were the years of cooperation and assistance received from Rose Ellen Potter of the Conservancy regarding transportation, weather and road conditions. and camping permits. Boat transportation to the island was often provided by Moe Gorelick, without whose help and support the initial stages of the study could not have been completed. Transportation on or around the island was courteously provided by Dave Howell and Steve Dawes (Santa Catalina Island Conservancy), Robert Given (U.S.C. Marine Science Center), Murray Crow (Wrigley Botanic Garden), and Edwin Smythe (Avalon). For permits. transportation, and accommodations needed for the collecting and studying of *Strymon* on the other Channel Islands, I thank Ron Dow, U.S. Navy (San Nicolas Island), Jan Larson and Howard Ferguson. U.S. Navy (San Clemente Island), William Ehorn and Nicholas Whelan. U.S. National Park Service (Santa Barbara. Anacapa. and San Miguel Islands), Lyndal Laughrin and Adrian Wenner, University of California. Santa Barbara (Santa Cruz Island).

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Various comments and the exchange of ideas were important additions to my study. These were offered by Larry Gall (Yale University), whose own studies on the island have added much to the knowledge of Santa Catalina Island butterfly endemics. Also appreciated was the *Strymon* museum specimen data and plant locality information provided by Scott E. Miller (USNM) and David Faulkner (San Diego Museum of Natural History). Steve Kutcher, John F. Emmel, Ted L. Hanes and J. A. Powell kindly edited the manuscript prior to publication. The last two years of this study were funded by a grant issued by the Xerces Society.

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Update on Conservation from MONCON II: Notes on the Second International Conference on the Monarch Butterfly and the Preservation of Overwintering Colonies

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Abstract

The activities and papers delivered at the Second International Conference on the Monarch Butterfly (MONCON) are discussed. Although much work remains to be done, both in California and Mexico, substantial progress is being made in North America toward conserving the monarch butterfly and its overwintering sites.

MONCON II, the first symposium ever to focus solely upon ecological, biological, and evolutionary aspects of the monarch butterfly *(Danaus plexippus L.)*, took place in Los Angeles in early September, 1986. The Los Angeles County Museum was a gracious host to the more than fifty researchers and conservationists who attended the meetings. Participants from Mexico, Costa Rica, Peru, Australia, the United Kingdom, West Germany and the United States shared their knowledge and enthusiasm about the monarch through four days of presentations, discussions, and informal brain-storming sessions.

The meeting was a sequel to the first conference on monarch conservation, held at the joint meeting of the Lepidopterists' Society and La Sociedad Mexicana de Lepidopterologia in Cocoyoc, Morelos, Mexico in 1981. The presentation of an honorary chairperson's gavel to Fred Urquhart (in absentia) opened the symposium. He was honored in recognition of his many years of pioneering research on the migration of the monarch, culminating in the 1976 discovery of the overwintering colonies in Mexico.

The papers presented at MONCON II ranged from the conservation of overwintering colonies in Mexico and California to egg-laying strategies in Australia, and the global evolutionary history of the genus *Danaus*. The papers were grouped by field of study, each section moderated by a prominent scholar in that area. The authors and titles of the papers are listed on the conference program, reproduced at the end of this article.

Update on Conservation Efforts

While the monarch is relatively abundant throughout most of its North American range, its well-known overwintering concentrations on the coast of California and in the mountains of central Mexico have been designated as threatened phenomena by the IUCN. The butterflies return each year to the same localities and form dense aggregations on tree branches, where they spend about three winter months in reproductive inactivity. Because the monarchs' critical habitats in both of the overwintering regions are naturally restricted by ecological factors, they are particularly susceptible to human destruction. In both Mexico and California, human activity is taking such a toll that the overwintering phenomenon stands in imminent peril of destruction. This tragedy would undoubtedly have a catastrophic effect on the familiar summer populations of migrant monarchs throughout the North American continent.

The Current Situation in Mexico

President Miguel de la Madrid and the Mexican government have recently taken a major step for the conservation of the overwintering colonies in Mexico. Heralded by praises in the New York Times and Science magazine (233: 1252-1253), a presidential decree protecting the monarchs was signed just three weeks after the conclusion of MONCON 2, on Sept. 30. As of October 9, the declaration was published in the Federal Register, establishing a 16,110 hectare ecological reserve for the monarchs in their montane forest habitat. The decree delineates five conservation areas, each consisting of a central core and an encircling buffer zone. Within a core zone, or zona nucleo, exploitation of the forest, its flora and fauna have been banned indefinitely. The only human activity allowed will be research. The buffer areas, zonas de amortiguamiento, will eventually be open to some economic activities, but all use must first be authorized by SEDUE, the Urban Development and Ecology Secretariat. The core areas range in size from 245 to 1060 hectares, while the buffer zones contain between 989 and 6787 hectares.

Other recent conservation moves include SEDUE's purchase of 700 Ha of privately owned land through the Monarca Fund, and the expropriation of an additional 80 Ha by the state government of Michoacan. All of these actions indicate a continued strengthening of Mexican conservation policy, and reflect both state and federal governments' increasing commitment to ecological concerns.

In the past, Mexico's unique land tenure system has complicated the designation of national parks or preserves in the monarch overwintering region. Most of the critical habitat areas are held by ejidos, community-owned and organized farms established during land reforms some fifty years ago. The rights to use ejido land are constitutionally guaranteed to members of ejido community, but the land may not be sold, leased or given away. The PRI (Partido Institicional Revolutionario), Mexico's leading political party, must weigh carefully the consequences of conservation laws that bear on the ejiditarios and other campesinos, in order to maintain crucial political support.

Monarca A.C., Mexico's influential monarch conservation organization, is substantially responsible for the passage of the decree and other government activities related to the monarchs. Its unfailing lobby efforts have been paramount in shaping Mexican policy towards the monarch butterfly in the last seven years. At the conference, Rodolfo Ogarrio, Fernando Ortiz Monasterio and other members presented diverse aspects of the Monarca A. C.'s multi-level approach to monarch conservation in Mexico. They emphasized the need for local control and management of the overwintering areas, so that regional human welfare might improve while the natural ecosystem is maintained. The region's traditional economy relies heavily on the exploitative use of the forest and its products, which directly conflicts with the mandated preservation of the monarch overwintering areas. Monarca A.C. is exploring alternative sources of livelihood for the local people which do not conflict with or actually promote conservation objectives. The ultimate hope is to establish a long-term, mutually beneficial relationship between local inhabitants and the monarch butterflies.

Monarca A.C. considers tourism to be central to the compatibility of conservation and the local population. A blossoming public interest in the monarchs brought more than 40,000 visitors to see the overwintering colonies during the 1985-86 winter, and numbers are expected to climb in subsequent seasons. Susana Rojas suggested that a visitor center and craft shop selling locally produced souvenirs could benefit the local economy, while promoting non-consumptive use.

Laura Snook, of Mexico's Instituto Nacional de Investigaciones sobre Recursos Bioticos (INIREB), presented a scenario for the monarchs' future in Mexico in sharp contrast with Monarca A.C.'s optimism. She reported that virtually all of the remaining oyamel fir forests have been subject to severe degradation from commercial timber harvest, local cutting for firewood, and fires and grazing which destroy forest regeneration. A large and rapidly growing population (some 20,000 people now inhabit the immediate area of the butterfly preserves) and low agricultural productivity accelerate rates of forest clearing in the region, resulting in irreversible damage to the fragile montane ecosystem. Snook suggested that fundamental shifts in the current economic and subsistence practices will be necessary to alter the trends of forest degradation and destruction. She proposed intensified silvicultural and agricultural activities outside the preserve areas and population control through family planning and emigration as possible components of a successful long-term management scheme.

Monarch Conservation in California

Most of California's more than forty coastal overwintering areas are seriously threatened by real estate and agricultural development interests. Chris Nagano and Melody Allen of the Monarch Project, the Xerces Society's organ devoted to the conservation of monarchs in California, reported on progress in several different aspects of the struggle to save these ecologically and economically valuable plots of land.

The Monarch Project has recently completed a survey of overwintering sites in California, documenting areas from Mendocino County south to the Mexican border. This intensive search led to the discovery of several previously unknown coastal sites and confirmed the existence of a remarkable inland colony on the western slope of the Saline Valley, near Death Valley. To plot the complete distribution of the sites was an important goal set forth at the first MONCON, and the survey's completion helps to set conservation priorities over the entire range of monarch roosts on the West Coast.

Despite the Monarch Project's efforts, the forces of attrition have taken their toll on many of the privately owned roosting areas in California. As many as seven monarch overwintering areas have been lost in the last three years to real estate development and other human activities. Although laws in many municipalities protect the monarchs during their winter dormancy, there is no blanket legislation regulating the destruction of monarch habitat during the summer months. It is against the law to kill one of the butterflies, but it is perfectly legal to cut down a tree in which thousands of them habitually roost.

Given the modest resources of the Monarch Project, constant vigilance of all the sites along California's 1,200 mile coastline is impossible. The group has therefore concentrated its efforts on creating cooperative dialogues with landowners and developers in order to heighten awareness and increase the chances for future conservation agreements.

One of the most innovative methods employed by the Monarch Project is the conservation easement, in which the landowner signs over the rights to those portions of the ecosystem which support the monarchs on his/her property. This places ownership of the monarch habitat with the Monarch Project, and gives them potential legal recourse if the habitat is degraded in any way. The judicial process for dispute resolution and retribution of damages to monarch habitat destruction has yet to be seriously tested. Penalties for illegal development work may amount to little more than slaps on the wrist. Some concern was voiced at the conference that the proposed punishments for violations of conservation regulations might be too mild: a developer might be willing to pay a nominal fine for destroying monarch habitat if s/he could construct a few extra million-dollar condominiums on the site.

While good will for the monarch butterfly abounds among the citizens of California, surprisingly high level of ignorance about their basic biology is common. Many people are unaware of overwintering colonies other than the commercially-publicized site at Pacific Grove. Another of the Monarch Project's goals is to increase the levels of public monarch-awareness through frequent media exposure.

The most heated controversy of MONCON 2 was initiated by Adrian Wenner of the University of California at Santa Barbara, who hypothesized that the western monarch does not actually migrate at all, based on his observations in the Santa Barbara area. Wenner did not support his hypothesis with any numerical data, but asserted that there was no quantitative proof to show that the monarchs actually do migrate. The claim was quickly refuted by Chris Nagano, who pointed out that tagged monarchs recovered at California overwintering sites have migrated from as far away as Idaho. Wenner's observations nevertheless illustrate the need for further research into the complexities of monarch migration.

That the press amplified Wenner's observations and the ensuing uproar into a full-blown controversy is indeed unfortunate. The scientific and conservation communities have much advisory power and public esteem to lose through this kind of squabbling within the ranks. It is important to remember that the public realm often has only a rudimentary understanding of the nuances of scientific dialogue, which allows anti-conservation political forces to take advantage of academic dispute. We must keep in mind that, at least fundamentally, we are all rooting for the same side.

Correction

In Luiz Otero and Keith Brown's article appearing in *Atala* Vol.10-12, in Table 1 on page 14, add *Parides bunichus diodorus* to the "Cerrado domain" entry under "*Parides* present." This addition should also contain a superscript 1.

Abstracts of Papers Presented at the 13th Annual Meeting of the Xerces Society

4-8 June 1986
Port Orchard, Washington USA

Scarabs - the bug society. *Sharon J. Collman. Cooperative Extension, Washington State University, 312 Smith Tower, 506 Second Avenue, Seattle WA 98104 USA.*

Scarabs is an assemblage of amateur and professional entomologists in the Pacific Northwest. The group takes its name in part from a similar association led by Dr. Melville Hatch (of *Beetles of the Pacific Northwest* fame), which met informally in the homes of members until Hatch's retirement in the mid 1960s. Like any group, Scarabs has at times stumbled. But because of the members' strong desire to meet and exchange ideas, it has always recovered its balance and grown just a bit stronger. The first Scarabs meetings began in January 1981. Washington State University Cooperative Extension sponsored the start-up of the organization for two years, by providing initial leadership and underwriting newsletter and postage costs. Now on its own, the group meets monthly for a formal program presented by members or guest speakers and an informal exchange of information, publishes a monthly newsletter, and organizes field trips for members. The group has also been actively involved in events to educate the public about insects. These include a large display at Science Circus, a 7-10 day event sponsored by the Seattle Science Center over the Christmas/New Year holiday week. They have also invited the public on a field trip to a local park to learn about insects. Several Scarabs are actively involved as IPM Volunteers, a Washington State University Cooperative Extension volunteer program. Currently, the Scarabs has 51 members, most of whom are active. Dues cover the cost of duplicating and mailing the monthly newsletter.

IPM Volunteers - contributions to northwest entomology. *Sharon J. Collman. Cooperative Extension, Washington State University, 312 Smith Tower, 506 Second Avenue, Seattle WA 98104 USA.*

Volunteers loosely organized under the umbrella of IPM Volunteers are engaged in local research and in teaching the public about insects. Many of the volunteers are also Master Gardener volunteers or Scarabs members. Under the auspices of Washington State University Cooperative Extension, the number of members of IPM (Integrated Pest Management) Volunteers has fluctuated from as high as 76 to the present 35. Rather than being involved in a formalized program, some volunteers move in and out, working on specific projects and leaving as these are completed; others have been involved in such ongoing projects as yellowjacket research, plant problem diagnosis, insect identification, and a butterfly study group. The yellowjacket research group has been monitoring heptyl butarate baited traps since 1982. Traps are emptied weekly and the yellowjackets identified to species, and counted during the monthly meeting. The Volunteers have contributed significantly to the knowledge of the western Washington populations of these hymenopterans. The Butterfly Study Group initially was organized to gather information about butterflies in urban environments, gather references, and record observations on species occurences and nectaring preferences in gardens. Our observations are shared with the Evergreen Aurelians. The group is just completing a small, low-budget field guide to aid others in identifying species common in lowland King County. The IPM Diagnosticians are a group of Master Gardeners specially trained in plant problem diagnosis. They identify, seek out information, and respond to inquiries from the public on insects of houses and gardens, and plant problems. They keep data on pest occurences and their sites. and hope to gain support to analyze further the information so it can be used in planning future educational programs. Other volunteers have been variously engaged in teaching children about butterflies, staffing public displays, guiding young amateurs, monitoring insect populations, teaching gardeners about insects, and developing teaching materials. Not only have the volunteers grown in their knowledge and appreciation of insects, they have magnified their understanding through the many people whom they reach and teach as volunteers.

The impact of grassland management on diurnal Lepidoptera in the Swiss central Alps. *Andreas Erhardt. Botanisches Institut der Universitaet Basel, Schoenbeistrasse 6, 4056 Basel, SWITZERLAND.*

In subalpine central Switzerland (Tavetsch Valley), studies were made of the day-active Lepidoptera faunas in different types of cultivated grassland, in various successional stages in the development of abandoned grassland, and in woodlands (climax vegetation). The investigation was performed with a modified transect method. The results show a close correlation between butterfly fauna and vegetation type. This is true in regard to both the variety of species and their sheer number. Characteristic differences were also found between the Lepidoptera faunas of north- and south-facing slopes. Species richness is highest in early stages of abandonment and falls rapidly with the arrival of shrubs and trees. It is also high in traditionally lightly cultivated grassland (unfertilized mown or lightly grazed meadows), but it declines rapidly with increasing intensity of cultivation. In general, species richness of butterflies is closely correlated with that of vascular plants. However, cultivation methods and the abandonment of lightly cultivated grassland for short periods of time (under 5 years) influence the species richness of Lepidoptera and of vascular plants in strongly different ways. These results stand in contrast to former studies in central Europe and parallel studies conducted in England. The natural primordial habitats of butterflies that have spread into vegetation types originated by man are discussed as well as the implications for nature conservation. The optimal strategy for conservation would be to preserve a balanced combination of the various types of vegetation. However, the most endangered vegetation types are unfertilized mown and lightly grazed meadows. These can be preserved only if traditional cultivation practices are maintained.

The Devil's Tower National Monument refugium, final report. *Clifford D. Ferris. Director, Bioengineering Program, P.O. Box 3351 University Station, University of Wyoming, Laramie WY 82071 USA.*

In 1983, a three-year study was initiated to inventory the insects present in Devil's Tower National Monument situated in northeastern Wyoming. The project terminated at the end of the calendar year 1985. The study area is unique in that it has never been subjected to pesticides, while the surrounding agricultural region is a chemical potpourri owing to the heavy use of herbicides and pesticides for many years. The vegetation types present in the Monument include short-grass prairie, oak forest and coniferous forest. Insects dependent upon these vegetation types occur within the confines of the Monument, but many of these species have not been collected in similar environments in the surrounding agricultural lands. This paper discusses lepidopterous insects that are apparently highly sensitive to pesticides and may be used as "indicator species" to assess the effects of chemical spraying programs, using the data obtained from the Devil's Tower project.

Lomas Barbudal Reserve: a Costa Rican dry forest treasure. *Gordon W. Frankie. Department of Entomology and Parasitology, University of California, Berkeley CA 94720 USA.*

Lomas Barbudal Reserve in Guanacaste Province became an official member of the Costa Rican Parks System on 23 January 1986. The idea for conserving the 2400 hectare dry forest site grew out of a desire to protect several groups of native bees (about 250 spp.) that were known to pollinate a large number of plant species in Guanacaste. Many bee species are known to be abundant at the Reserve because of a high diversity of nesting habitats that are available to them. In addition to the bees, Lomas Barbudal can boast of two other unique features. One of these is undisturbed savannah and riparian habitats. Each contains distinct floral and faunal elements. The final unique feature is the abundant water that flows from a river/creek system and several perennial/ephemeral springs. Because of these water resources, Lomas Barbudal supports a highly diverse flora and fauna. Opportunities for acquiring new property for protecting extant habitats and for expanding under-represented habitats are excellent at this time.

Conservation of *Speyeria* butterflies on six types of native prairie across the central United States. *Paul C. Hammond. 2435 East Applegate, Philomath OR 97370 USA.*

This talk focuses on the *Speyeria* butterflies and the native wildflowers found on six types of native prairies across the central United States, between the Appalachian and Cascade ranges. Emphasis is placed upon the historical destruction of these ecological communities and present day conservation requirements. Altogether, six species of *Speyeria* and six species of *Viola* are found on these various prairie types, each having specific habitat requirements.

The Oregon Silverspot Project. *David C. McCorkle and Paul C. Hammond. Biology Department, Western Oregon State College, Monmouth OR 97361 USA.*

The Oregon Silverspot *Speyeria zerene hippolyta* is presently limited to a few coastal salt-spray meadows and associated habitats in Oregon. Aspects of the life history of this butterfly, and features of the meadows are discussed, as are the results of research on the habitat requirements of the butterfly and its habitat management. The role of the several involved state and federal agencies is also explained.

Invertebrates at risk in the Pacific Northwest. *Robert M. Pyle. Swede Park, 369 Loop Road, Gray's River WA 98621 USA.*

The Invertebrate Red Data Book of the IUCN highlighted a number of threatened invertebrates endemic to Washington and/or Oregon. Several others have been identified, and the number of endangered or vulnerable arthropods and other invertebrates in the region may be substantial. The combination of varied habitats and intensive land use leads to organisms at risk. Some of the species considered are the Oregon Silverspot, the Oregon and Washington giant earthworms, the Wood Roach (*Cryptocercus*), the Mount St. Helens grylloblattid, Tartar's stentor, and the Columbian tiger beetle. The efforts of the Evergreen Aurelians and the Northwest Lepidoptera Survey to map the region's butterfly fauna and to highlight rarities and their management needs are discussed. State heritage program and nongame program overtures toward invertebrate surveys are examined, along with the Xerces/OSU/WSU representative habitat inventory plans. To what degree is a species approach versus a habitat approach appropriate for invertebrates, and are these orientations really at odds?

The western states Butterfly Mapping Project, current status. *Ray E. Stanford and Paul A. Opler. 720 Fairfax Street, Denver CO 80220 USA.*

Having published previously, respectively, range maps of the Rocky Mountain region and eastern USA butterflies, the authors are now preparing maps of the western USA butterflies. The maps will include touching portions of Canada and Mexico, and will show nearly 100,000 dots (dubious records will be shown by a different symbol on these maps). We hope to have these maps available by the end of 1986 or early 1987.

The apparent extinction of the endemic moth *Urania sloanus* (Lepidoptera, Uranidae) in Jamaica, West Indies. *Tom W. Turner. P.O. Box 6272, Clearwater FL 33518 USA.*

The endemic moth *Urania sloanus* has not been collected in Jamaica since 1944, and is now believed to be extinct. Existing life history information is compared with those for related species, and the probability of rediscovering this insect on Jamaica is examined.

A new factor in the population decline of *Papilio homerus* (Lepidoptera, Papilionidae) in eastern Jamaica, West Indies. *Tom W. Turner. P.O. Box 6272, Clearwater FL 33518 USA.*

Factors believed responsible for the decline in adult flight range of this handsome swallowtail butterfly are reviewed. Rearing adults from immatures collected in the wild during 1985-1986 has revealed an unexpected new factor which may be adversely affecting the eastern island population. Suggestions for investigating this phenomonon further are discussed.

Commentary: the Potential Impact of DIPEL Spraying on the Monarch Butterfly Overwintering Phenomonon

Lincoln P. Brower
Department of Zoology
University of Florida
Gainesville, FL 32611 USA

Abstract

Current information about the ecological effects of DIPEL, a commercially produced bacterium-based biocontrol agent, was obtained by telephone canvassing a number of entomological and biocontrol experts. This information is assessed in light of a recent proposal to spray large areas in Mexico with the agent.

Background

Jose Sarukhan of the University of Mexico informed the author on 5 November 1986 that the Mexican Secretary of Agriculture and Water Resources (SARH) had sought Sarukhan's advice regarding an imminent program to spray 40,000 hectares of Abies religiosa forest in Mexico with DIPEL. SARH asked whether this would possibly endanger the monarch butterfly overwintering population, since the proposed spray region included the overwintering habitat of the northeastern population of the monarch butterfly *(Danaus plexippus* L.).

The stated reason for spraying was to control the larvae of a tortricid moth, apparently *Evetria (Rhyacionia) hyalinaria*, which is reputed to cause economic damage to the firs. This moth genus includes pine-shoot tortrix moths, serious pests of *Pinus* in the holarctic region. According to Sarukhan, a pilot *Abies* test area had already been sprayed, the results being inconclusive because of rainfall.

The author subsequently contacted a number of entomological and biocontrol experts by telephone regarding the SARH proposal. The present paper discusses the opinions obtained from this telephone canvas.

1. Nature and Production of the Spray DIPEL

DIPEL is a commercially prepared product of *Bacillus thuringienses*, known as BT in the insect control and pesticide industry. BT is a rod bacterium and a natural pathogen of some insects, especially Lepidoptera (butterflies and moths). For commercial production, the bacterium is grown in fermentation culture and produces spores which are harvested to become the main component of the spray. Numerous (about 70) BT strains have been selected for target lepidopteran species, including pests of citrus, banana, cabbage, spruce, cotton, tomato, and soybeans.

The spores from BT cultures are harvested by processes which are trade secrets of the companies; the spores are applied in liquid emulsions on infested plants. The toxin is so potent that about one quart is sprayed per acre if in an oil base, or 3 gallons per acre if in a water base (therefore, respectively, about 22,500 and 270,000 gallons of spray would be applied in Mexico). The application rate is measured in PIUs (potency international units), some 8-16 billion PIUs per quart per acre (this figure is derived from plating the mixture on agar plates and counting the number of spores producing colonies per unit volume of product, and is currently verified by chemical analysis).

DIPEL is produced by Abbott Laboratories, and is marketed as a water-wettable powder consisting mainly of BT spores. A related commercial preparation known as THURICIDE is produced by Sandoz Chemical Company, and comes as an oil-based flowable liquid suspension of spores.

2. Biological Mode of Action of DIPEL

Inside the BT spores occurs a highly toxic, diamond-shaped crystalline protein known as delta-endotoxin (DE). The extreme effect of DE is analogous to that produced by botulism toxin. The DE toxin is released via solubilization from the spores in an alkaline (8.5-10.0 pH) environment. A major reason for the selective toxicity of BT spores to Lepidoptera is that the larval midgut of these insects provides an alkaline environment. The precise modus operandi of DIPEL, then, is (1) the spores from the spray are ingested by lepidopteran caterpillars from the surface of their foodplants, (2) the spores are subsequently broken down by ingestion in the high pH milieu of the larval midgut, and (3) the toxic crytals are released. The toxin attacks the midgut wall, which breaks down and results in a reciprocal exchange of hemolymph (=blood) and the gut contents. This in turn causes paralytic shock, death, blackening, and liquefaction of the larva.

The half life of DE in the spores is affected by ultraviolet light, and varies depending upon the vegetational substrate upon which the spores land – on the order of hours to days on herbage and tree leaves, and up to several months on tree trunks.

Since DIPEL contains live spores, the spores can germinate and culture on the decaying remnants of infected larvae. In other words, biotic multiplication of the toxin can occur in the forest environment. While some of the investigators contacted here regarded this property as not being dangerous, the Japanese government is most wary about the use of BT sprays because of the potential susceptibility of the silkmoth industry to contamination with the spores.

3. Beta-Exotoxin: a Dangerous Contaminant

Some preparation of the BT spores, including older batches, contain a second toxin known as beta-exotoxin (BE). This is a nucleic acid derivative highly toxic to insects in all stages of development. BE interferes with cell replication, causes ovarian degeneration, and can result in teratological effects in adult insects.

Products containing BE are banned as insecticides in the United States by the Environmental Protection Agency. For fear of losing the entire BT control industry, lawsuits have arisen among the companies for marketing BT insecticides contaminated with BE. The only way to verify whether any lot is contaminated with BE is to record the following: (1) the company name and address, (2) the specific product name, (3) the fermentation batch number on the shipping containers, and (4) retain a quart of the spray for chemical analysis. The scientists contacted here who mentioned BE contamination raised an ominous point: namely, that out-of-USA shipments of BT insecticides may not be as tightly regulated as those destined for USA markets, and therefore that the product in Mexico may well have a higher likelihood of being contaminated with BE.

4. Effects of DIPEL on Adult Insects

One often heralded aspect of DIPEL (and the related products of other companies) is its reputed narrow range of targets. The larvae of some 50 species are sensitive, including larvae in the butterfly families Papilionidae, Pieridae, and Brassolidae, and the moth families Sphingidae, Noctuidae, Citheronidae, Lasiocampidae, Tortricidae, and Lymantridae. Some of the specialists emphasized that DIPEL does not affect bees and "beneficial insects," and is not known to affect adult moths.

However, the effects of DIPEL an adult butterflies are largely unknown, and virtually untested. Moreover, noone contacted here was aware of published data on the gut pH of adult Lepidoptera, so the likelihood of ingested spores releasing the toxin can not be assessed adequately. One expert, Elizabeth Bernays, predicted that adult gut pH values would probably be low to neutral, but she and all others interviewed advised caution, since killing would undoubtedly occur should the monarch butterfly's gut pH prove to be high.

5. Other Substances in the Spray

The liquid containing the spores has one or more sugar products in it, in addition to unspecified fermentation products. Because the ensporulated toxin is rapidly degraded by UV light, some preparations of the spores also have anti-UV chemical additives. One researcher contacted said that we need to know how the spray will be applied, and suggested that aerial spraying, to be more efficient, might require the use of a kerosene carrier. Other substances include toxicological adjuvants. stickers, spreaders, oil-based carriers, and various undefined company-classified chemicals. Of course, spray tanks and mixing containers may also be contaminated with DDT or other insecticides, and the danger to adult monarchs of all these additional components of the spray have not been ascertained.

6. Possible Infection Routes on Monarchs

Adult monarchs are in residence at several overwintering sites in Mexico from about 1 November to 15 April. Throughout the overwintering period monarchs drink dew both from the *Abies* fir needles they cling to in their clusters and from grass and forbs in clearings, and could therefore ingest BT spores from these water sources. Because the monarchs are carbohydrate stressed at the overwintering sites (they respond strongly to sugars by drinking), the presence of various sugars n the spray could stimulate excessive drinking, and hence the ingestion of high concentrations of spores.

Should toxin release not occur in the overwintering adults, it seems possible that the spores could survive in the adult guts. These spores could subsequently be passed via feces onto milkweed plants when the migrating females oviposit in March to reestablish the first spring generation in the southeastern United States. Thus, the first spring generation of monarchs could be at indirect risk to poisoning from the proposed spraying, even if adult mortality did not occur during winter.

7. *General Ecological Considerations*

According to Snook (1986), the *Abies religiosa* ecosystem is a remnant of a once widespread forest, which is now restricted to a few mountain ranges in Mexico (review by Brower, 1985). The proposed spraying would in effect target an entire relict ecosystem. Given that there are any number of probable, yet incompletely known side effects of spraying DIPEL on this ecosystem, Snook maintains that a thorough cost-benefit study needs to be carried out prior to spraying.

Holling advised against chemical spraying of natural ecosystems except under the most dire conditions. The usual course of events following such massive spraying is for pests ot increase in numbers, which in turn increases the expense and required intensity of subsequent rounds of spraying, and so forth. Holling also raised the possibility that the monarch and the tortricid pest, as well as other species may be ecologically linked. He urged that even if the tortricid pests are a significant problem, that spraying should not be carried out in the *Abies* forest ecosystem prior to obtaining a more complete understanding of the basic biology and interactions among its component plants and animals.

8. *Alternative Spraying Regimes*

SARH has also proposed two compromise spray programs: (1) maintaning a non-sprayed belt around the monarch sites, and (2) delaying spraying until 15 April so that overwintering monarchs have left Mexico.

Implementation of (1) would require an unrealistic effort to define and mark colony boundaries, and would most likely be negated by uncontrollable windborne drifting of the spray. Moreover, there is no reason to believe that wind-borne spray would not infiltrate the unsprayed overwintering sites in any event. The monarchs also fly for up to 2km from their colonies to sip water, and most probably would pass through sprayed areas. Even under alternative plan (2), it remains unclear whether BT buildup over the summer and fall would infect the subsequent year's overwintering monarch population (recall that retention of spores is on the order of months on tree trunks).

Conclusions

DIPEL spraying could do irreparable damage both to the unique Abies fir forest ecosystem and to the overwintering phenomonon of the monarch butterfly. Damage to the monarch population from a hastily thought out spraying program could prove to be a major embarassment to the Mexican Government, cause irreperable cultural loss, and result in the economic loss of a potential Mexican tourist industry. Given what is known of the monarch overwintering phenomonon, and the lack of evidence that BT spraying would be safe, the only sensible conclusion is not to spray. Persons having further information about DIPEL, and/or an interest in the spraying proposals are urged to contact the author at the address given at the head of this article.

Scientists Contacted via Telephone

Allen, Douglas (Dept. Entomology, SUNY Syracuse, Syracuse, NY 13120 USA): Bernays. Elizabeth (Dept. Entomology and Parasitology, UC Berkeley, Berkeley, CA 94720 USA); Boucias. Drion (Dept. Insect Pathology, Univ. Florida, Gainesville, FL 32611 USA); Buckingham, Gary (Dept. Entomology, Univ. Florida, Gainesville, FL 32611 USA); Dahlman, Douglas (Dept. Entomology, Univ. Kentucky, Lexington, KY 40506 USA);. Diamond, John (Dept. Entomology, Univ. Maine, Orono, ME 04473 USA); Dulmage, Howard (USDA, Brownsville, TX USA); Emmel, Thomas (Dept. Zoology, Univ. Florida, Gainesville. FL 32611 USA); Fusco, Robert (Northeast Field Representative, Abbot Laboratories, Harrisburg PA USA); Habek, Dale (Dept. Entomology, Univ. Florida. Gainesville, FL 32611 USA); Holling, C. S. (Institute of Resource Ecology, Univ. British Columbia, Vancouver, British Columbia, V6P 1W5 CANADA); Melin, Brian (Dept. 910, Chemical and Agricultural Products Division, Abbott Laboratories, North Chicago, IL 60064 USA); Sarukhan, Jose (Facultad de Ciencias, Inst. de Niologia UNAM, Ciud. Univ. 04515, Mexico 20 DF, Mexico); Scheibner, Rudy (Extension Entomologist, Univ. Kentucky, Lexington, KY 40506 USA): Snook, Laura (School of Forestry, Yale University, New Haven, CT 06511 USA).

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Undersurface details of the Avalon Hairstreak, *Strymon avalona*, a hairstreak endemic to Santa Catalina Island, off the coast of southern California. The species' biology, ecology, and conservation requirements are examined in the lead article of this issue. Line drawing by Glenn Gorelick.

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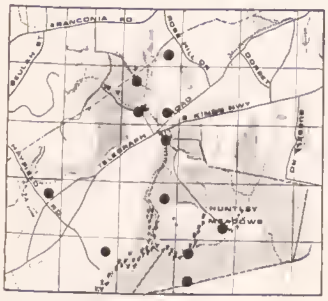

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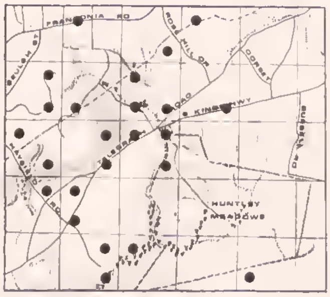

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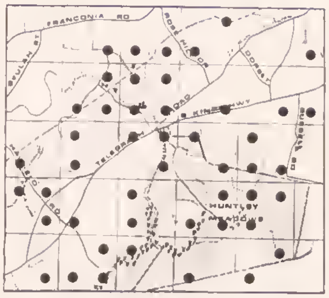

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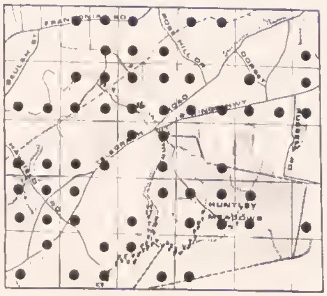

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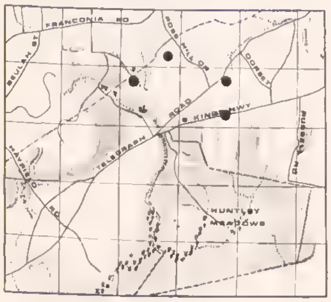

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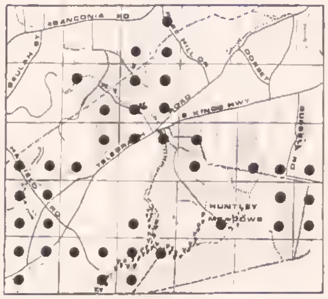

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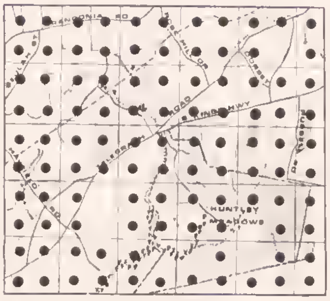
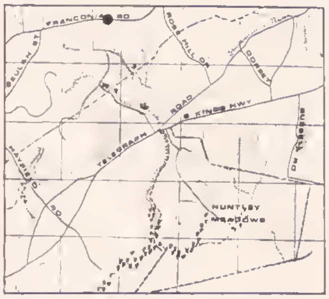
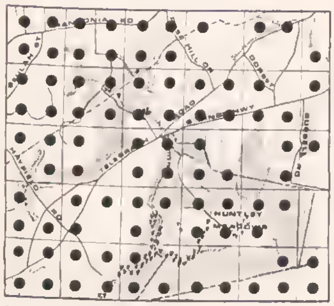


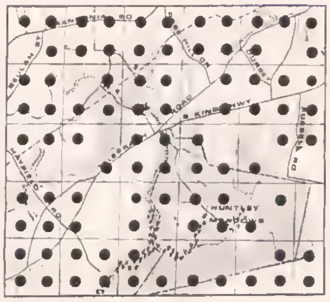
7 European Cabbage Butterfly (*Pieris rapae*)



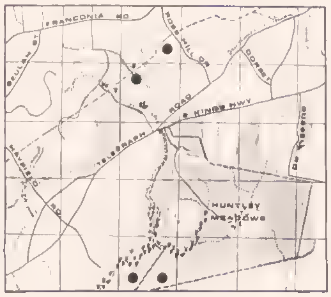
8. Checkered White (*Pontia protodice*)



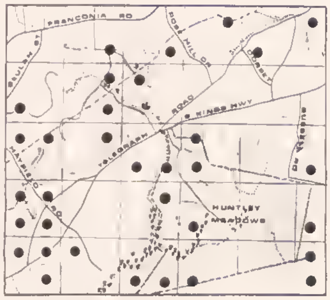
9. Alfalfa Sulfur (*Colias eurytheme*)



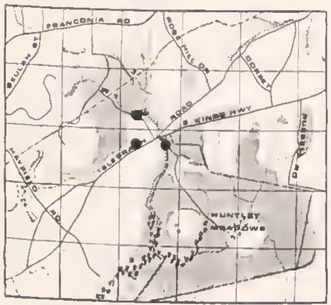
10. Clouded Sulfur (*Colias philodice*)



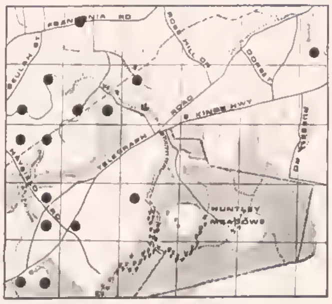
11 Sleepy Orange (*Eurema nicippe*)



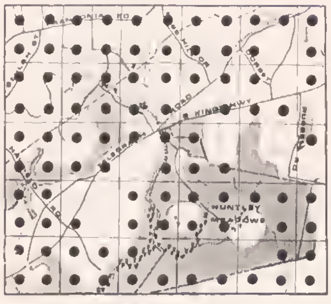
12. Little Sulfur (*Eurema lisa*)



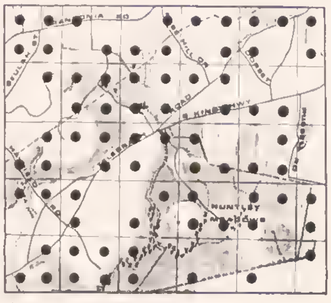
13 Harvester (*Feniseca tarquinius*)



14. American Copper (*Lycaena phlaeas*)



15. Tailed Blue (*Everes comyntas*)



16. Spring Azure (*Celastrina ladon*)

THE XERCES SOCIETY

An international organization dedicated to the conservation of rare and endangered invertebrates and their habitats. Named for the extinct Xerces Blue Butterfly, *Glaucopsyche xerces* (Boisduval). Founded on 9 December 1971.

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ATALA

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Articles

An Atlas of the Butterflies and Skippers of the Upper Dogue Creek Drainage, Fairfax County, Virginia, 1978-1982

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Abstract

A 4-year mapping survey of the butterfly fauna in a suburban northern Virginia locality is presented, along with habitat and ecological notes, and recommendations for management of the surveyed region.

Introduction

This survey and atlas project was undertaken primarily as a pilot study to demonstrate the use of the Universal Transverse Mercator (UTM) grid for the North American Invertebrate Survey. The area chosen was a 5 X 5.5 km area in UTM Zone 18S in the 100 km UT designated square in suburban northern Virginia, near the author's previous home in Rose Hill, Fairfax County, Virginia (Fig. 1).

Between 1978 and 1982, an attempt was made to visit all 0.5 X 0.5 km squares at different seasons when different species of butterflies might be found. Several quadrats could not easily be accessed, while others were visited many times due to their interest. Nevertheless, access to most was gained on public rights-of-way or without crossing fences or disobeying "no trespassing" signs.

I located 79 species of butterflies during the 5-year survey, an unusually rich array for a suburban area at this latitude (specimens of most species are deposited as vouchers in the National Museum of Natural History). Over the years in Fairfax County, at least 13 other species of butterflies have been found (Clark, 1932), primarily in the more western part of the county (e.g., at Great Falls or near Reston). For perspective, about 160 species are known for the state of Virginia as a whole, but some of these are limited to the mountains, coastal marshes or the swamps in the southeastern sector of the state (Covell & Straley, 1973).

More than 2300 species-square occurences were documented, for an average of 21 species per quadrat (range was 0 to 62 species per quadrat; Fig. 1). The lowest numbers were found in densely residential, commercial or in closely cropped lawn areas, as well as the dense mature woodland along Huntley Meadows County Park's southern edge (Fig. 2). I classes richest areas as those quadrats with 35 or more species. Such locations were usually open areas near forests and some wet areas or streams, those sites having a wide variety of plants, including caterpillar hosts and adult nectar sources.

Species of Special Note

A colony of the Dion Skipper *Euphyes dion* was found in the "boardwalk" marsh within Huntley Meadows County Park. This is the only known colony of this species in the Washington metropolitan area counties. Also seen in the east edge of the same marsh was a female Baltimore *(Euphydryas phaeton)*, although a colony was not found. Colonies were formerly known at what is now Washington/National Airport, and in the vicinity of Cabin John, Maryland, but occur there no longer. The species has generally been declining in the coastal plain near Washington and Baltimore. I found its caterpillar host, Turtlehead *(Chelone glabra)*, in the marsh behind the Coast Guard Station and along the pipeline right-of-way at the north edge of Huntley Meadows County Park.

A small colony of the Northern Hairstreak *(Fixsenia ontario)* was found near two small knolls on the Virginia Electirc and Power Company (VEPCO) powerline right-of-way in the Upper Dogue Creek drainage. This species is quite rare in most areas, and probably benefits from the management practice of cutting the right-of-way vegetation every other year. Two uncommon skippers, Leonard's Skipper *(Hesperia leonardus)* and the Dusted Skipper *(Atrytonopsis hianna)*, were also located, associated with stands of Little Bluestem Grass along the same VEPCO powerline and near where Barnyard Run crosses the old paved road in Huntley Meadows. Other butterflies recorded only a few times in the area are common elsewhere or are infrequent southern vagrants and not true residents.

Conclusions and Management Recommendations

The following management recommendations are made for the specific purpose of hoping to maintain the long-term diversity of butterflies and other organisms in the area. The current master plan for development of the area exists, but these recommendations should not affect such plans or may necessitate only minor alterations (rather, they are made to help local decision makers and cannot be construed as any sort of mandate).

1. Continue present management of the VEPCO powerline right-of-ways in the area. Do not change any of them to lawn planting or open them to use of herbicide use. The section running from the end of Treetop Lane west across the headwaters of Dogue Creek seems particularly critical.

2. Maintain natural vegetation corridors along Dogue Creek tributaries to the north of Telegraph Road so that dispersal is maintained with Huntley Meadows butterfly populations to the south.

3. Huntley Meadows park is fairly rich in plants and animals, but its richness could be enhanced by converting one or two small open fields to early successional stages, and by introducing appropriate larval hosts and nectaring plants that would enhance butterfly and other insect species richness. These areas should be mowed once a year in the fall. Some plants common outside the park which favor butterflies, but that are either absent or rare within the park include: Common Milkweed *(Asclepias syriaca)*, Butterflyweed *(Asclepias tuberosa)*, Dogbane *(Apocynum cannabinum)*, Queen Anne's Lace *(Daucus carota)*, Sheep Sorrel *(Rumex acetosella)*, Common Selfheal *(Prunella vulgare)*, Lamb's Quarters *(Chenopodium album)* and Bittercress *(Cardamine vulgaris)*. Candidate areas for such introductions are those already disturbed e.g., those along the first part of the paved park road already containing some artificial plantings.

Literature Cited

Clark, A. H. 1932. The butterflies of the District of Columbia and vicinity. U. S. Natl. Mus. Bull. 157: 1-337.

Covell, C. V., and G. B. Straley. 1973. Notes on Virginia butterflies, with two new state records. J. Lepid. Soc. J. Lepid. Soc. 27: 144-154.

Correction

In *Atala* Volume 14(1) [1986], top p. 17, Tom Turner's abstract should read "...since 1894, and is now..."(date change).

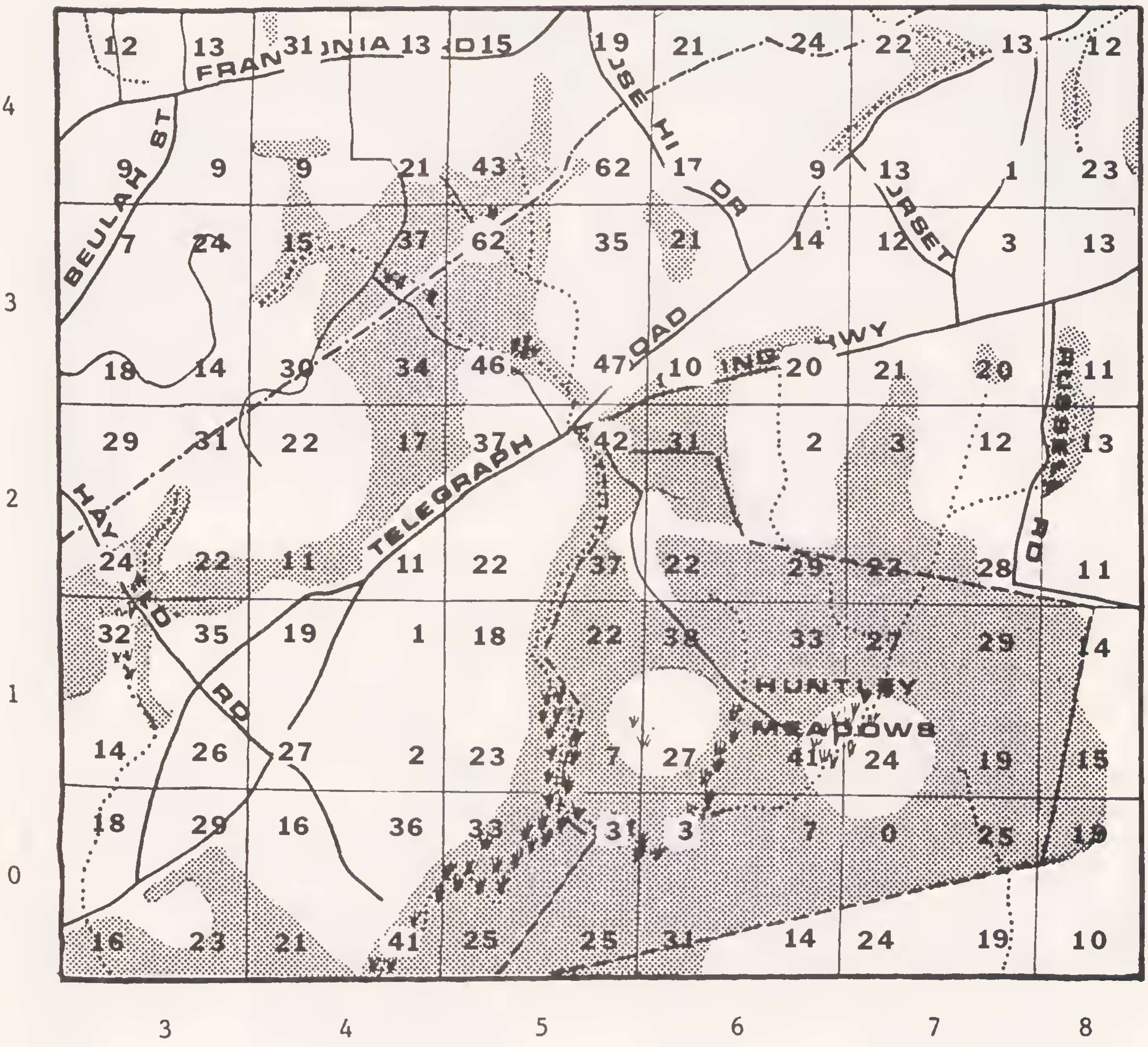


Figure 1. Surveyed area, showing one kilometer UTM designations along margins. In the center of each 0.5 X 0.5 km quadrat is shown the total number of butterfly species encountered during the survey.

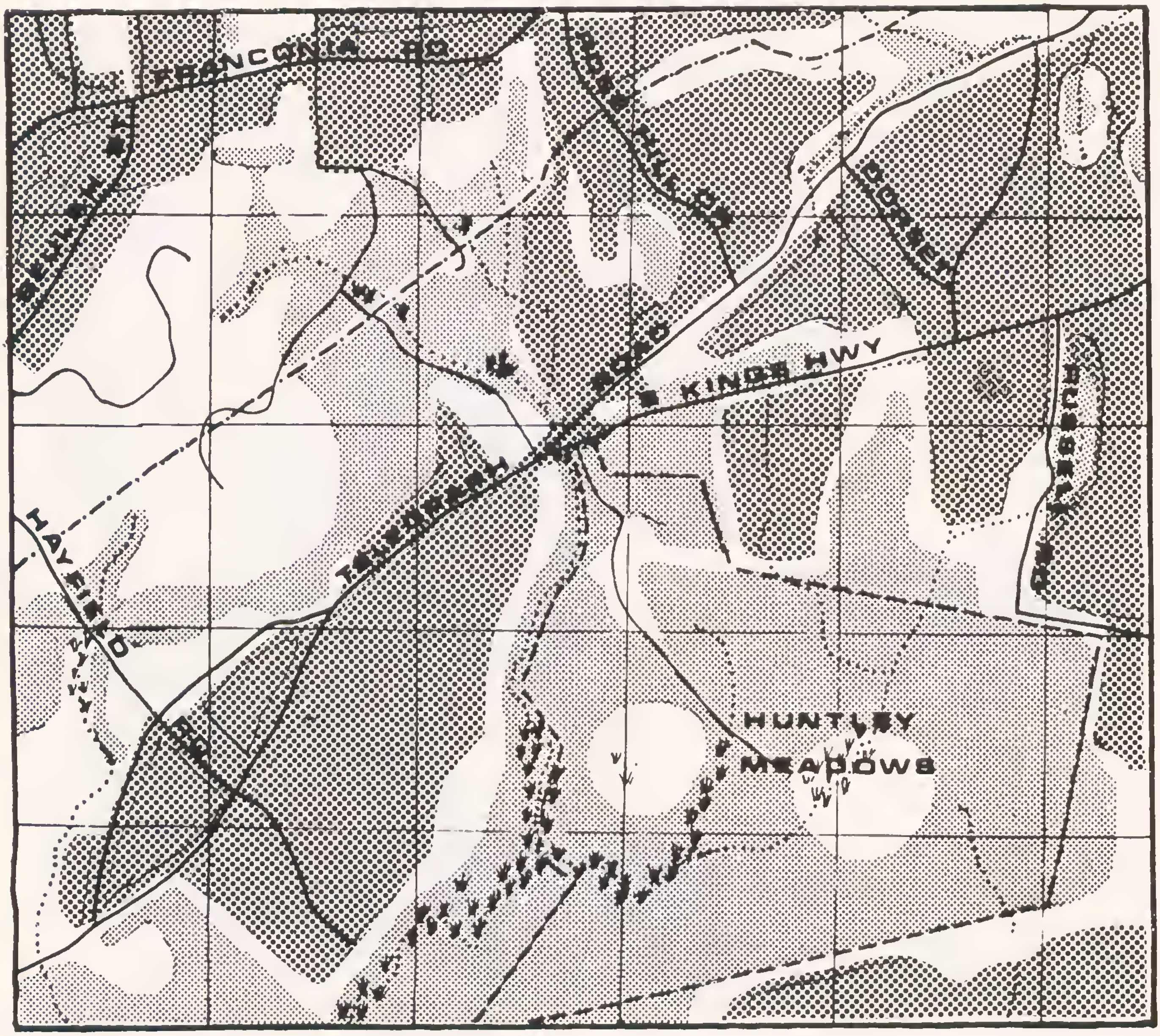
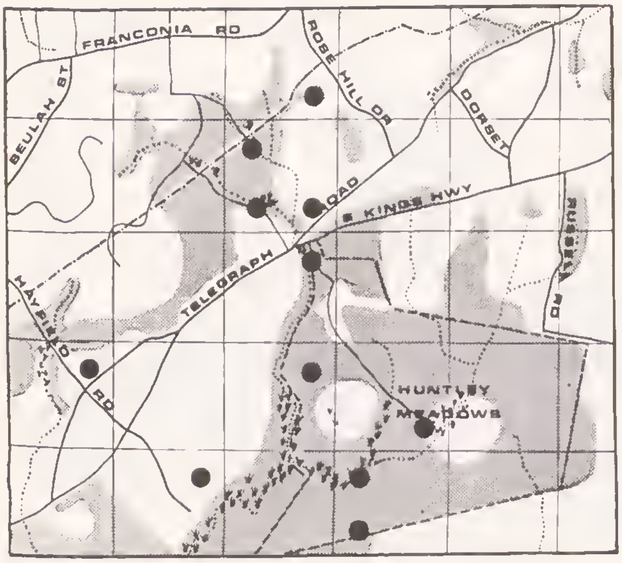
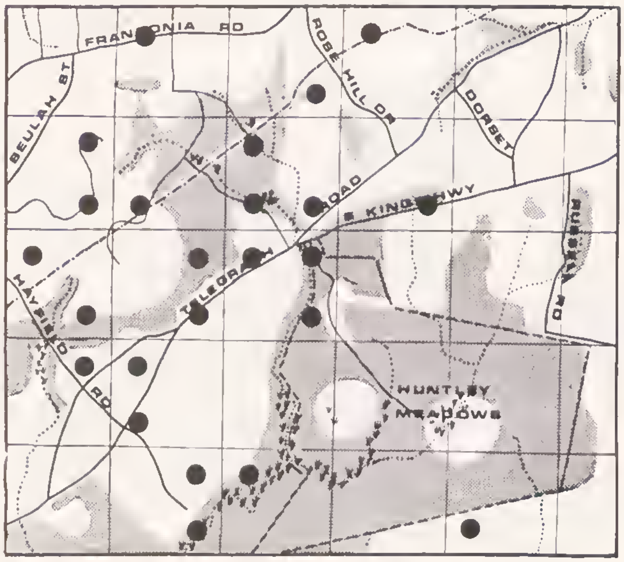


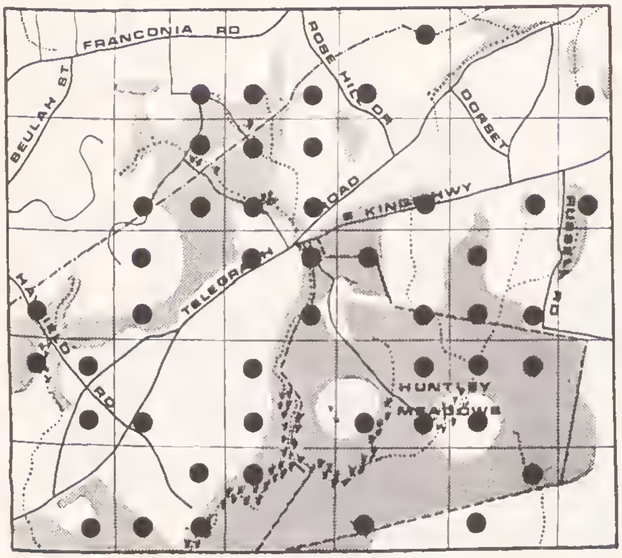
Figure 2. Upper Dogue Creek Drainage as of 1982. Heavily shaded areas indicate dense housing and extensively close-cropped lawn areas, and business areas not suitable for the vast majority of butterfly species. Light shaded areas are natural forests (mostly young successional). Unshaded areas are open fields. Solid lines are roads (dirt or paved). Dotted lines are creeks or small streams, those with plants indicate bogs or marshes. Power lines indicated by alternating dots and dashes. Huntley Meadows Park is surrounded by a dashed line.



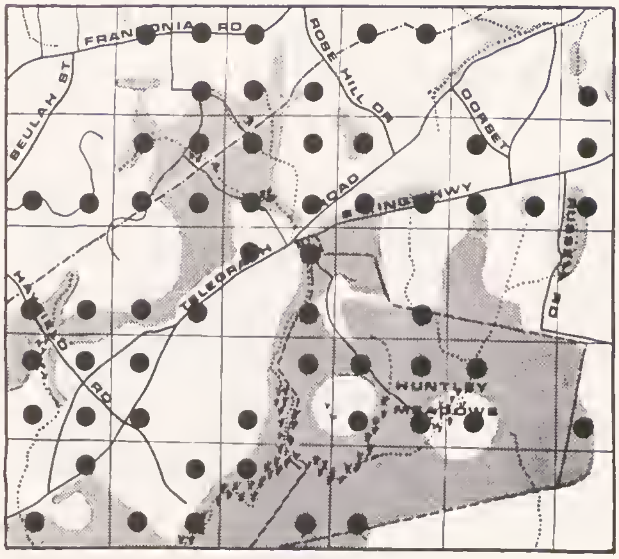
1. Pipevine Swallowtail (*Battus philenor*)



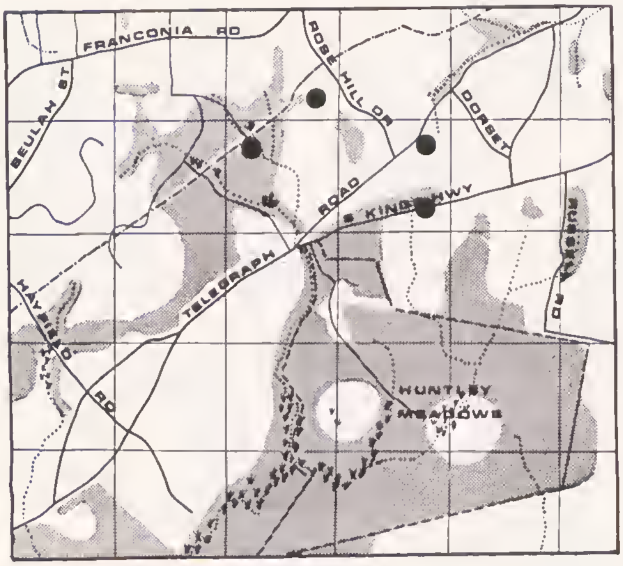
2. Black Swallowtail (*Papilio polyxenes*)



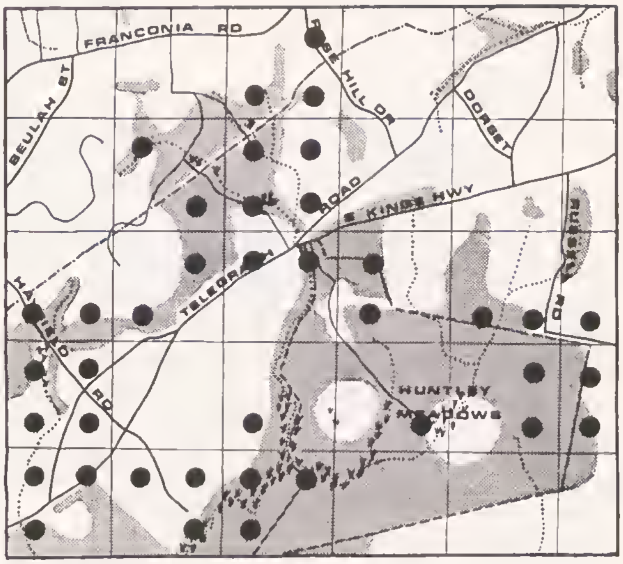
3. Spicebush Swallowtail (*Papilio troilus*)



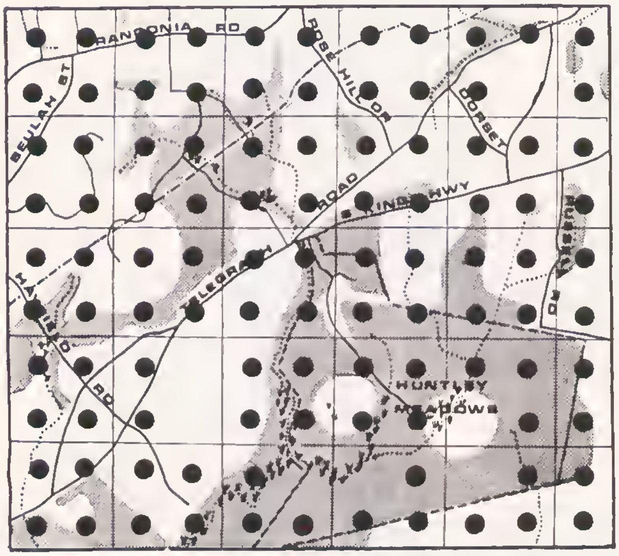
4. Tiger Swallowtail (*Papilio glaucus*)



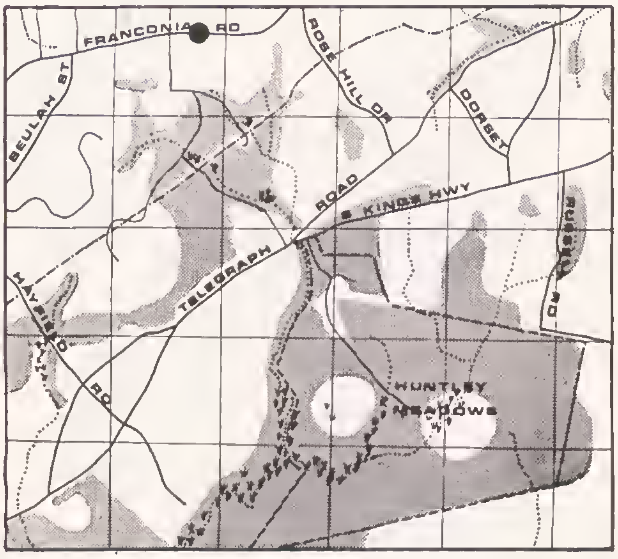
5. Zebra Swallowtail (Eurytides marcellus)



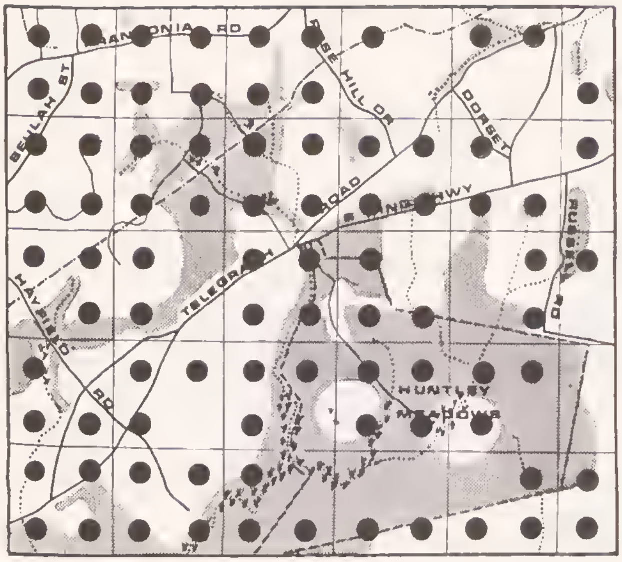
6. Falcate Orange-tip (Anthocharis midea)



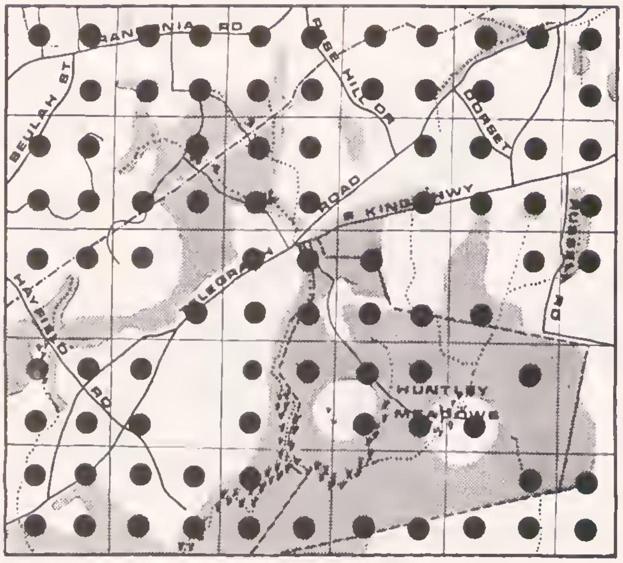
7. European Cabbage Butterfly (Pieris rapae)



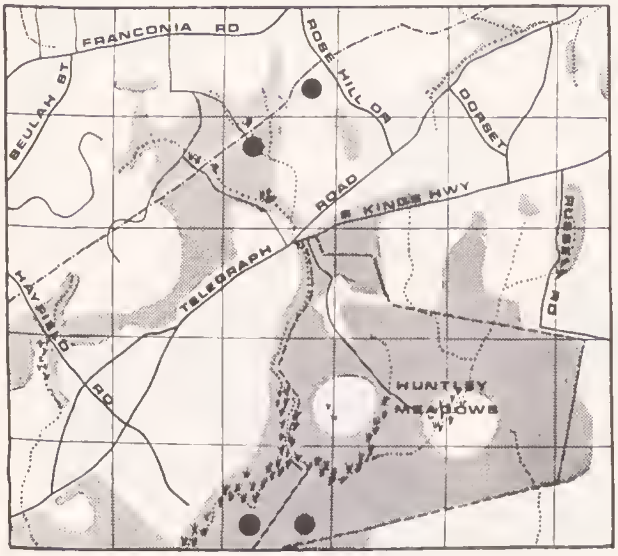
8. Checkered White (Pontia protodice)



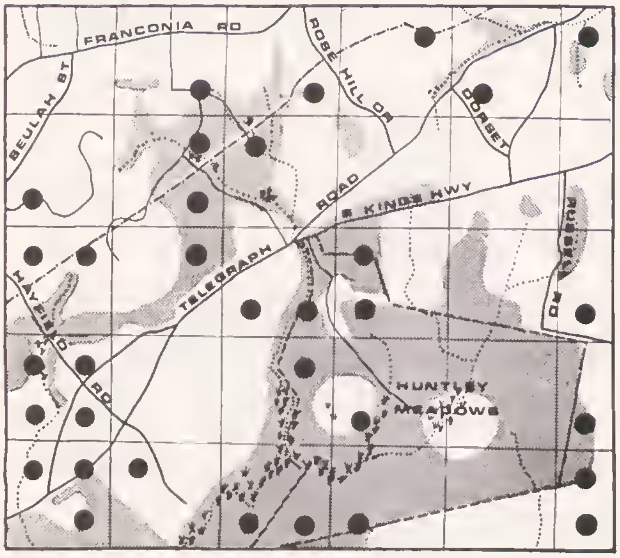
9. Alfalfa Sulfur (Colias eurytheme)



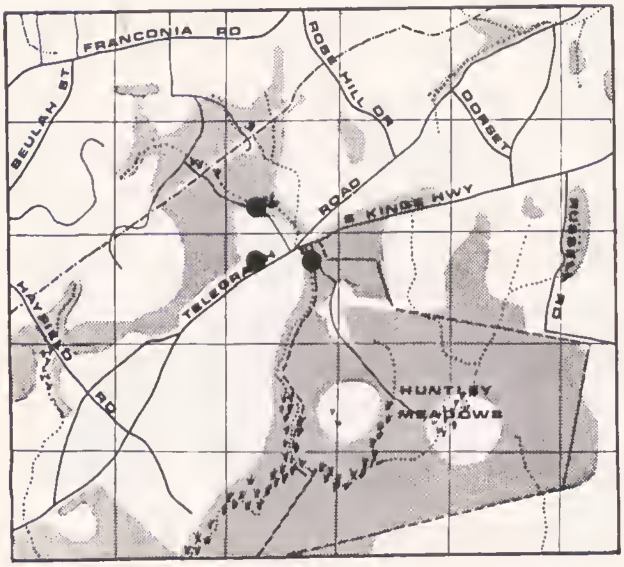
10. Clouded Sulfur (Colias philodice)



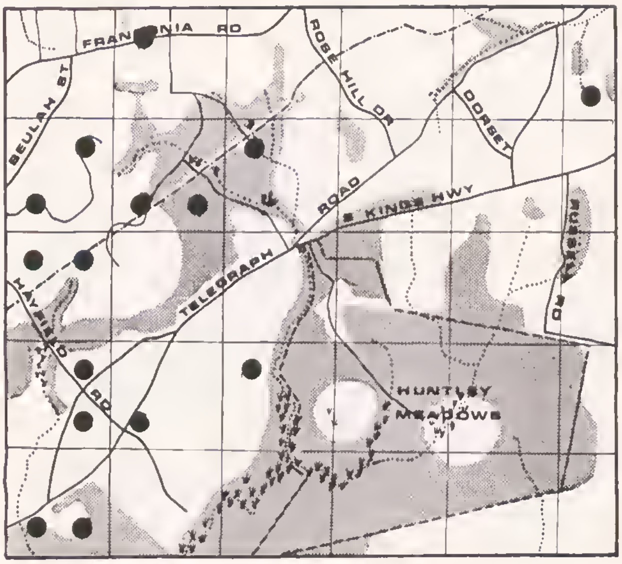
11. Sleepy Orange (Eurema nicippe)



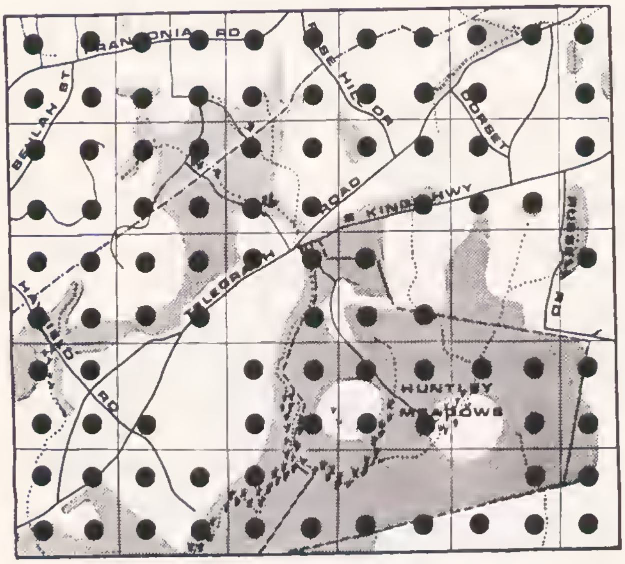
12. Little Sulfur (Eurema lisa)



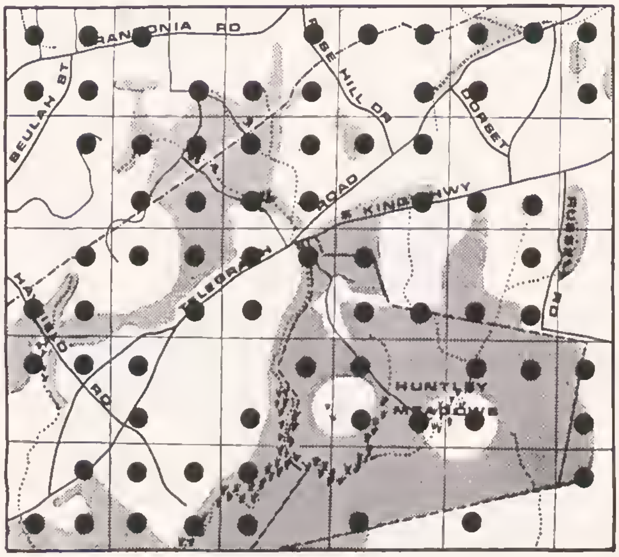
13. Harvester (Feniseca tarquinius)



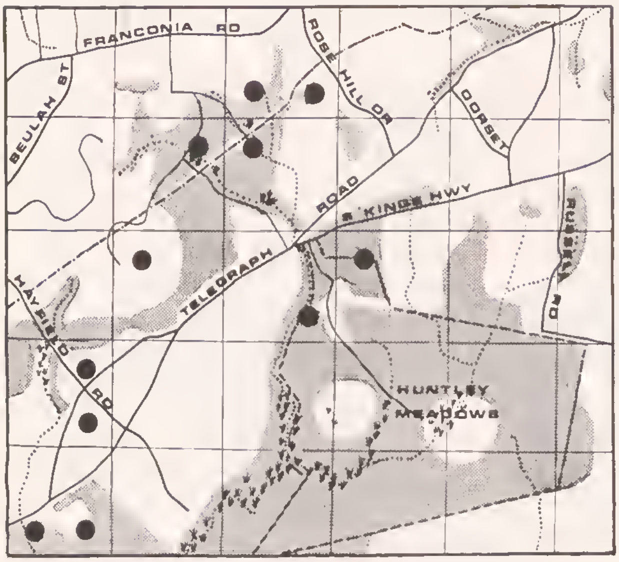
14. American Copper (Lycaena phlaeas)



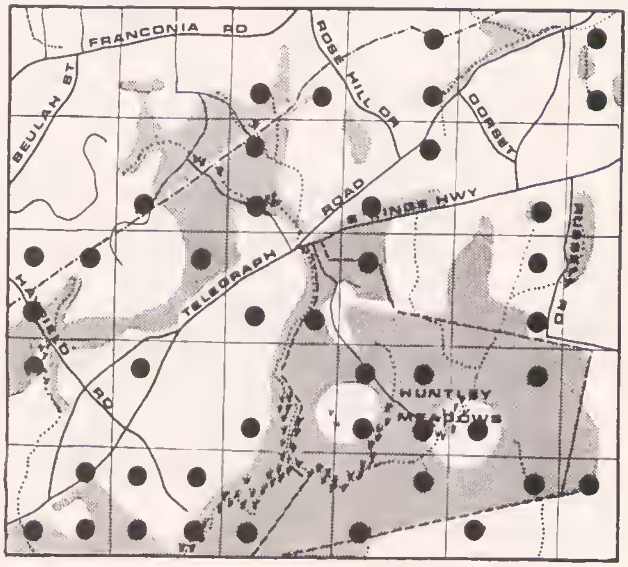
15. Tailed Blue (Everes comyntas)



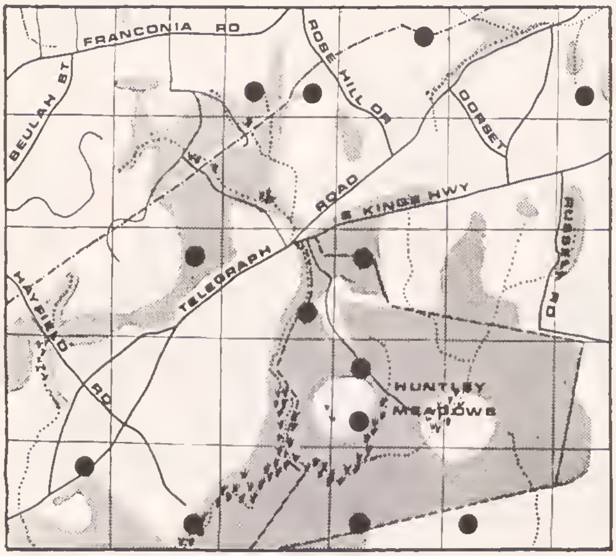
16. Spring Azure (Celastrina ladon)



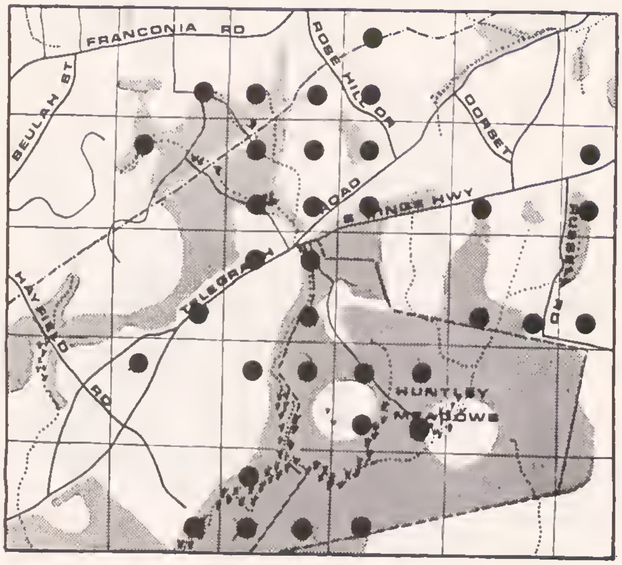
17. Coral Hairstreak (Harkenclenus titus)



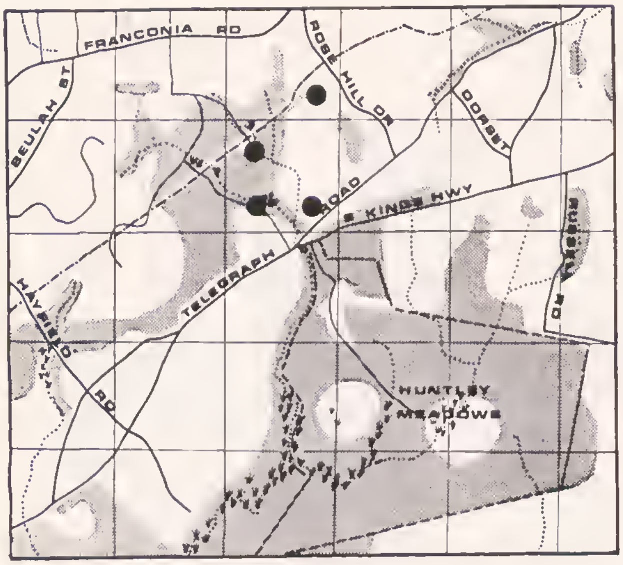
18. Banded Hairstreak (Satyrium calanus)



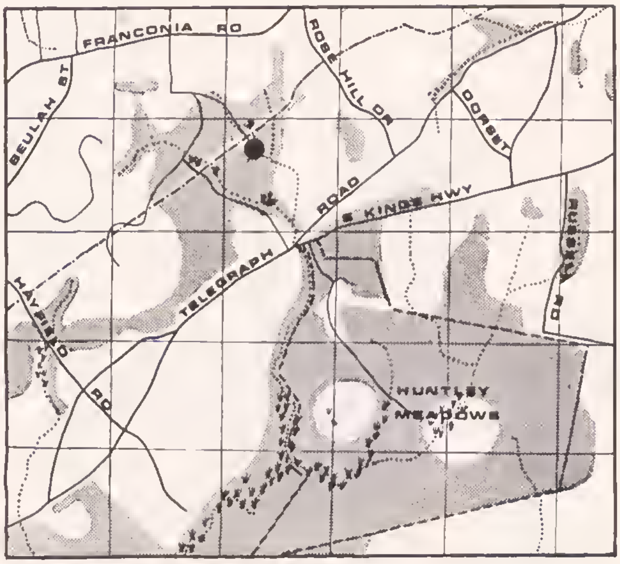
19. Striped Hairstreak (Satyrium liparops)



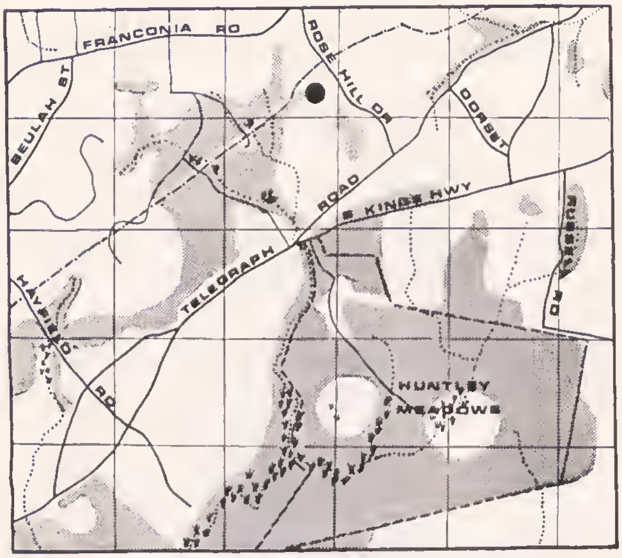
20. Red-banded Hairstreak (Calycopis cecrops)



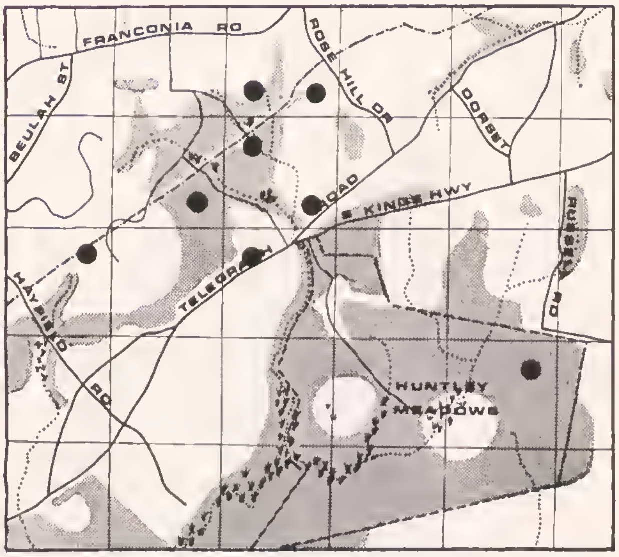
21. Olive Hairstreak (*Mitoura gryneus*)



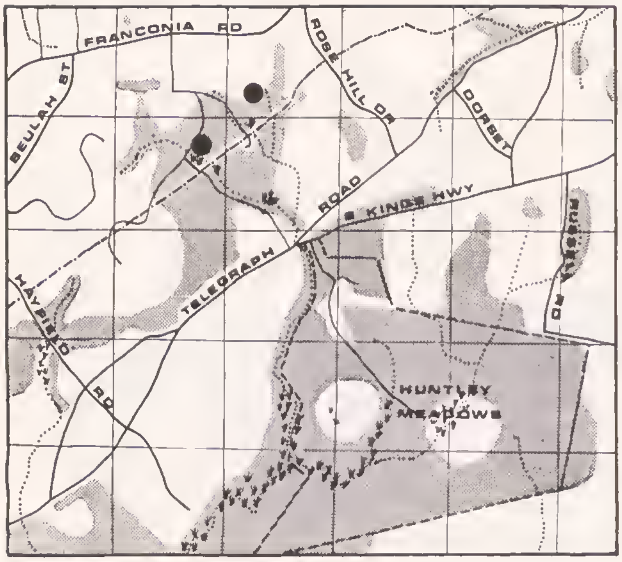
22. Brown Elfin (*Incisalia augustus*)



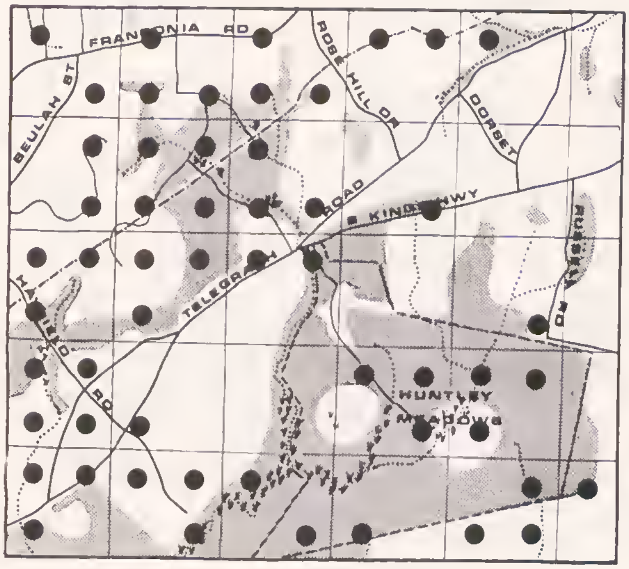
23. Henry's Elfin (*Incisalia henrici*)



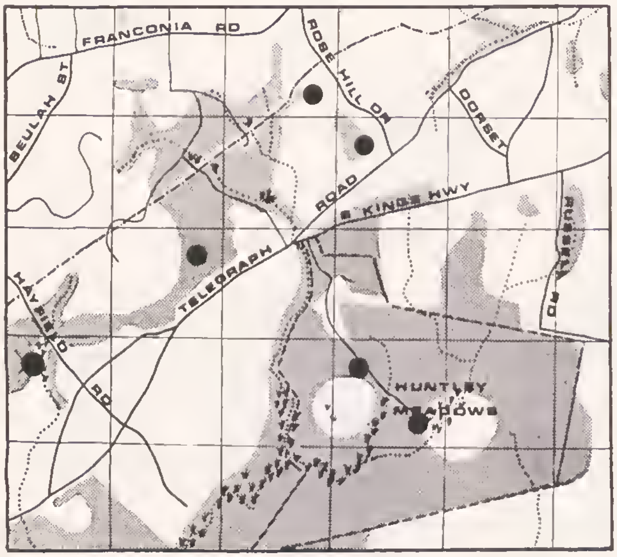
24. Banded Elfin (*Incisalia niphon*)



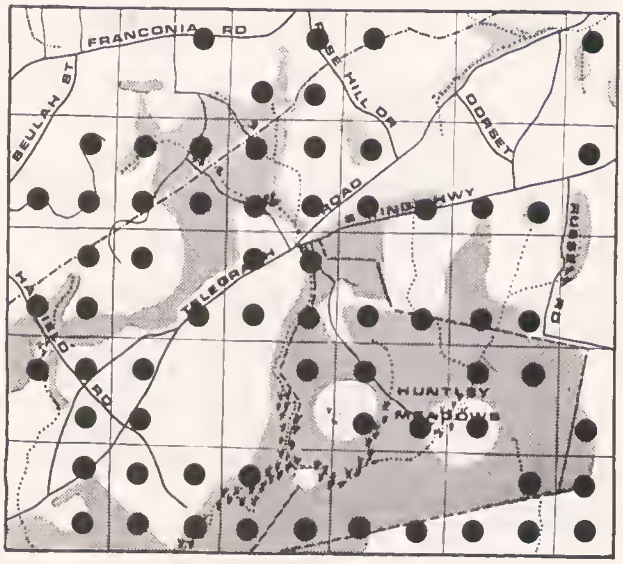
25. Northern Hairstreak (Fixsenia ontario)



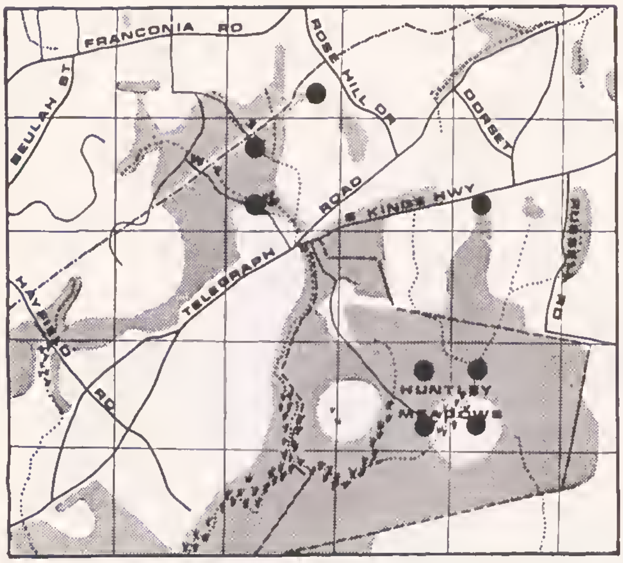
26. Gray Hairstreak (Strymon melinus)



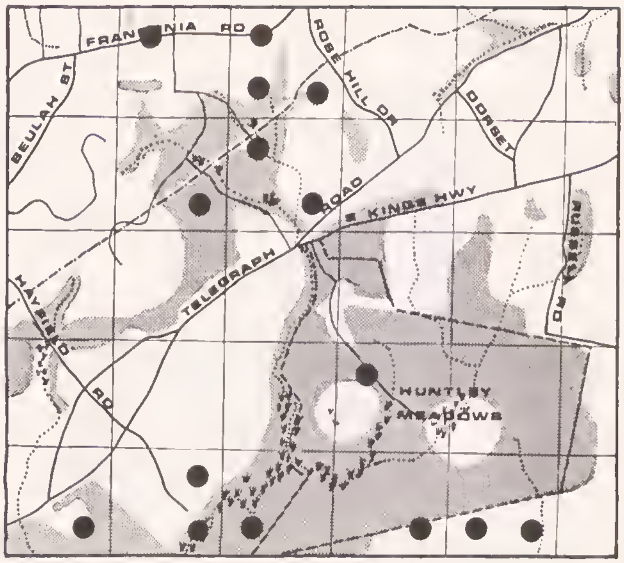
27. White M Hairstreak (Parhassius m-album)



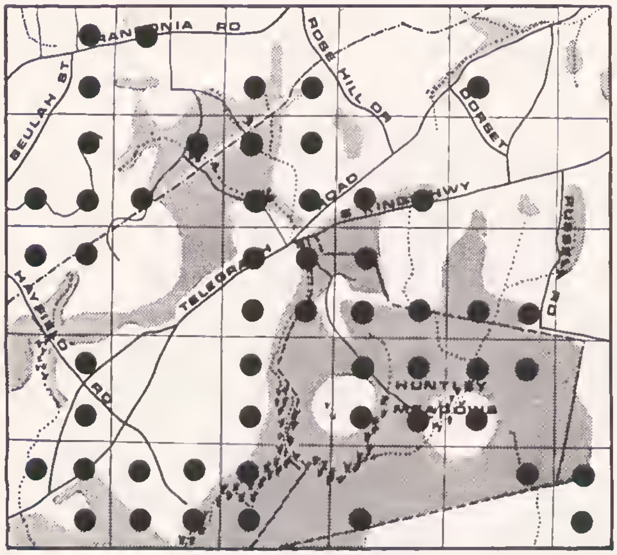
28. Monarch (Danaus plexippus)



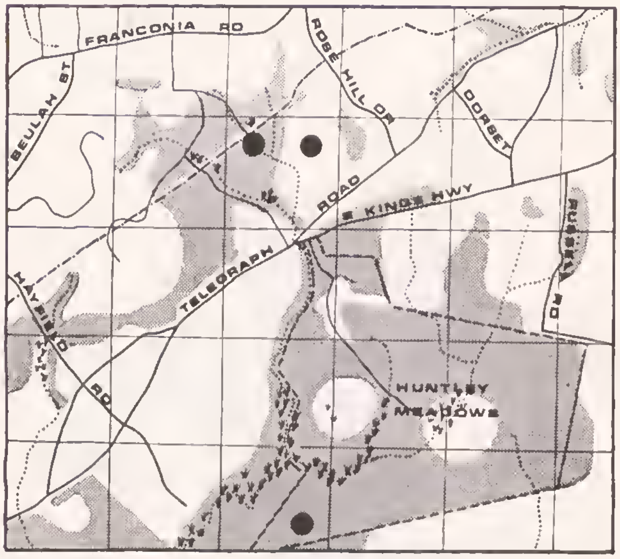
29. Snout Butterfly (Libytheana bachmani)



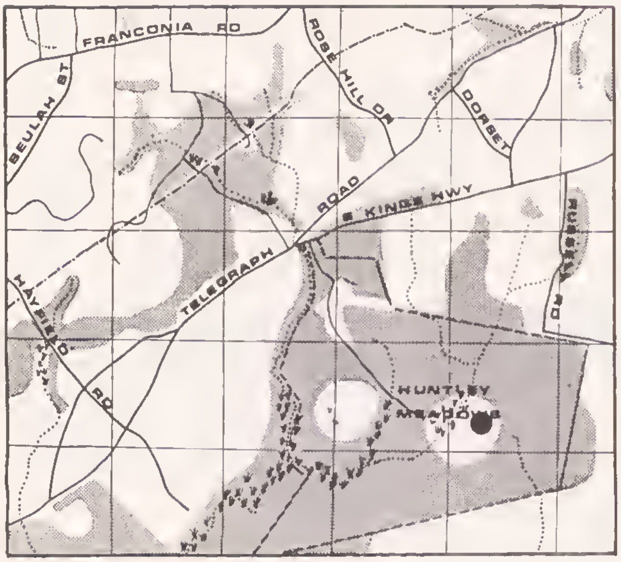
30. Variegated Fritillary (Euptoieta claudia)



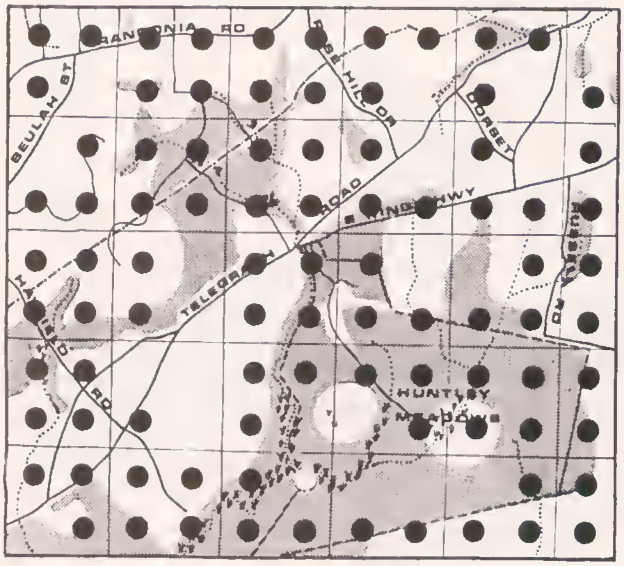
31. Great Spangled Fritilary (Speyeria cybele)



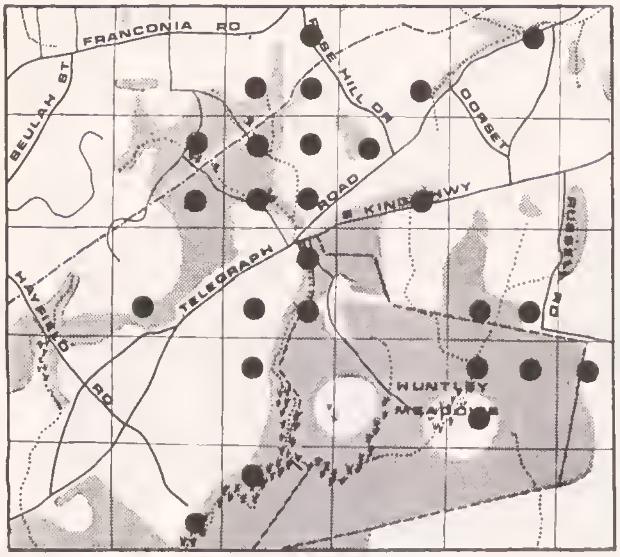
32. Meadow Fritillary (Boloria bellona)



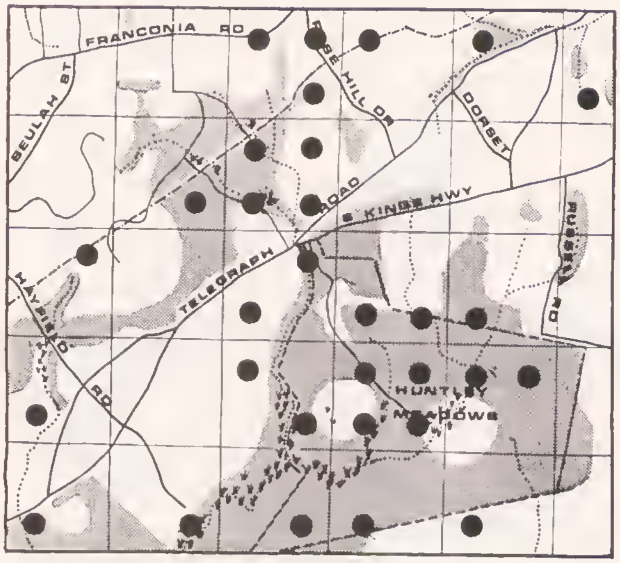
33. Baltimore (*Euphydryas phaeton*)



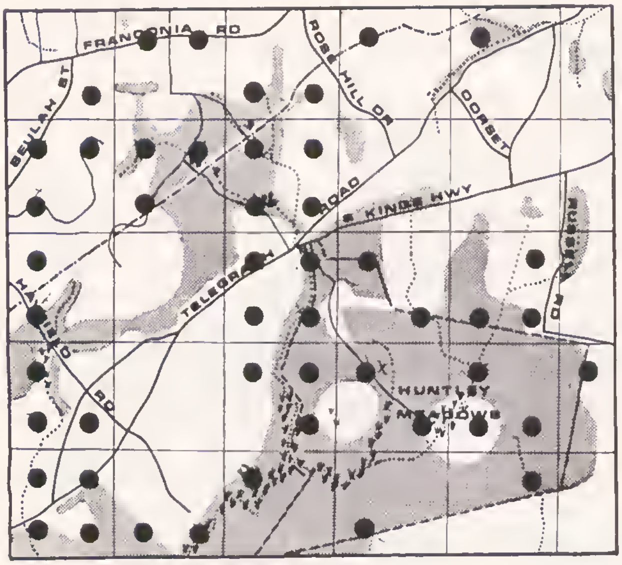
34. Pearl Crescent (*Phyciodes tharos*)



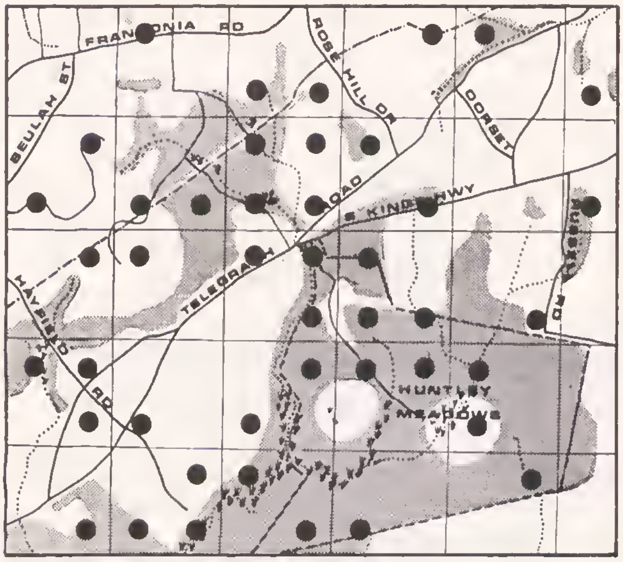
35. Comma (*Polygonia comma*)



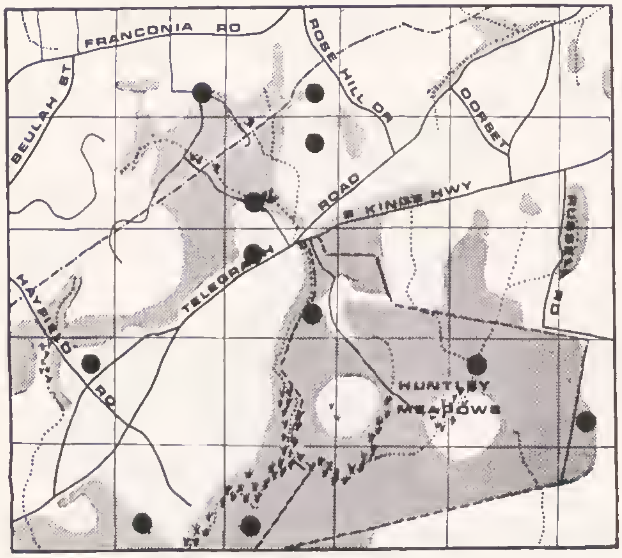
36. Questionmark (*Polygonia interrogationis*)



37. Mourning Cloak (*Nymphalis antiopa*)



38. Virginia Lady (*Vanessa virginiensis*)



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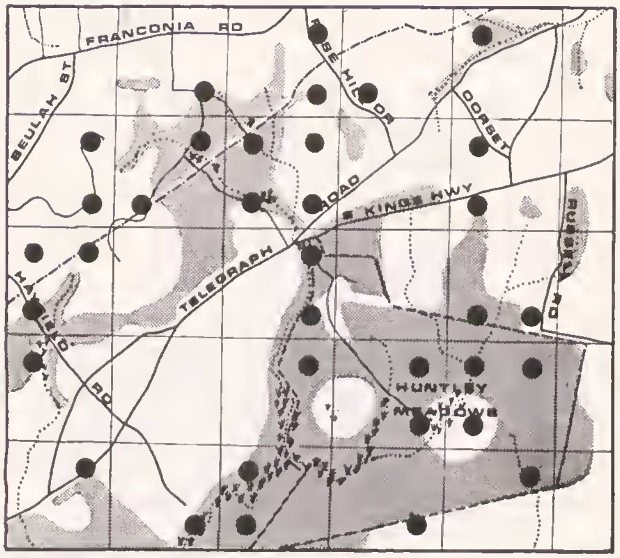

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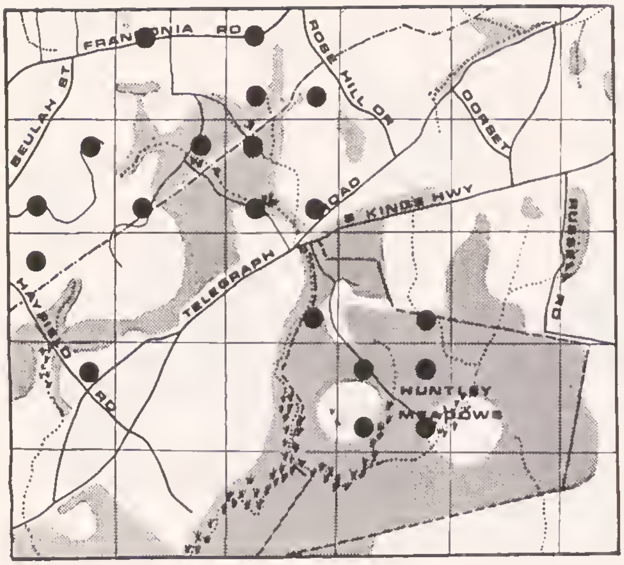

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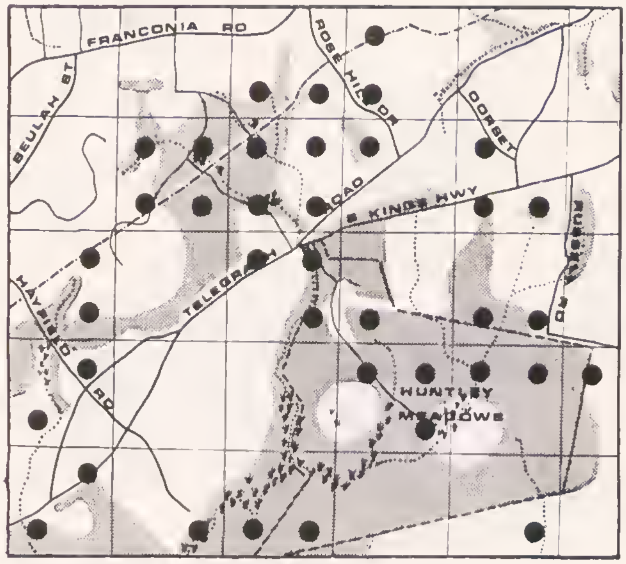
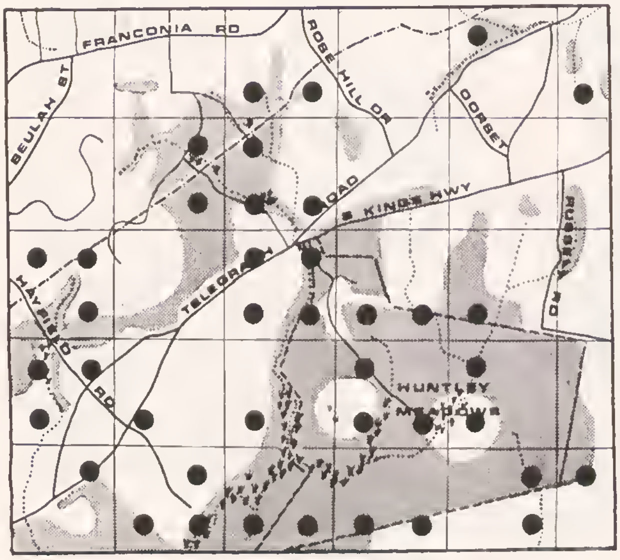


42. Red-spotted Purple (*Limenitis astyanax*)



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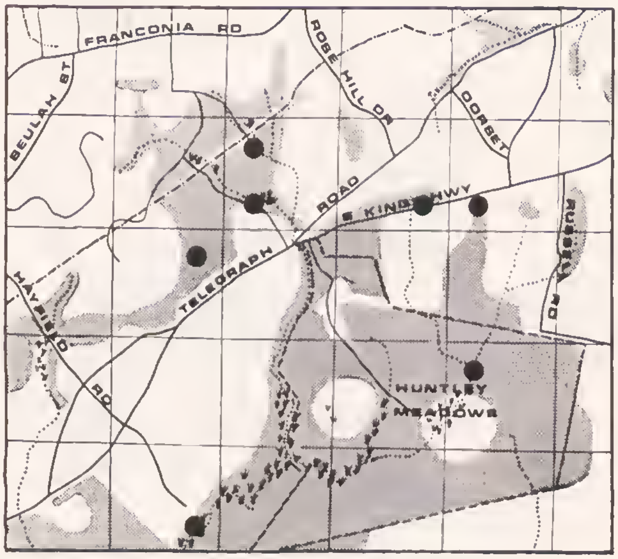

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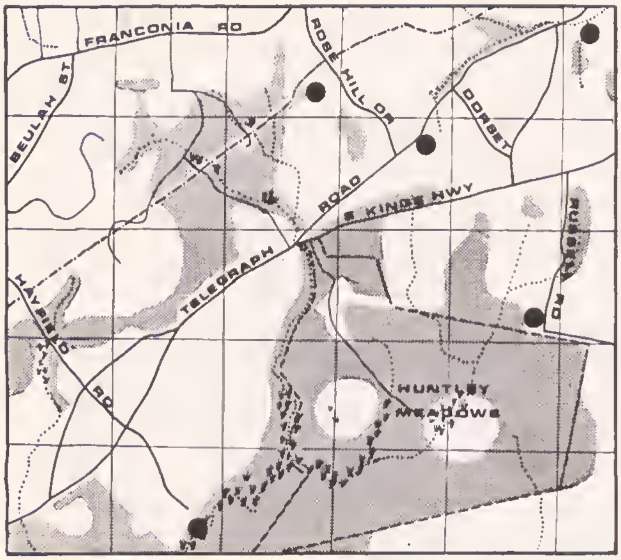

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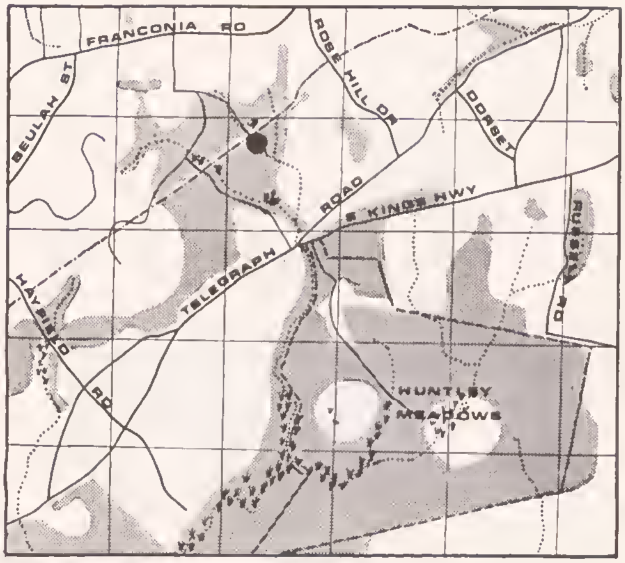

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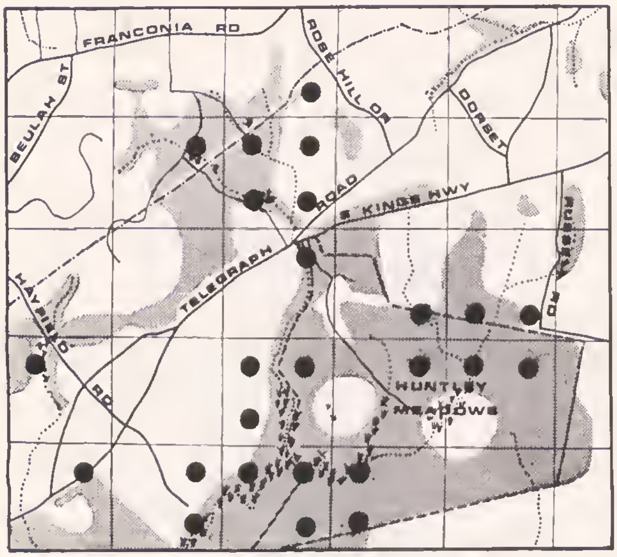

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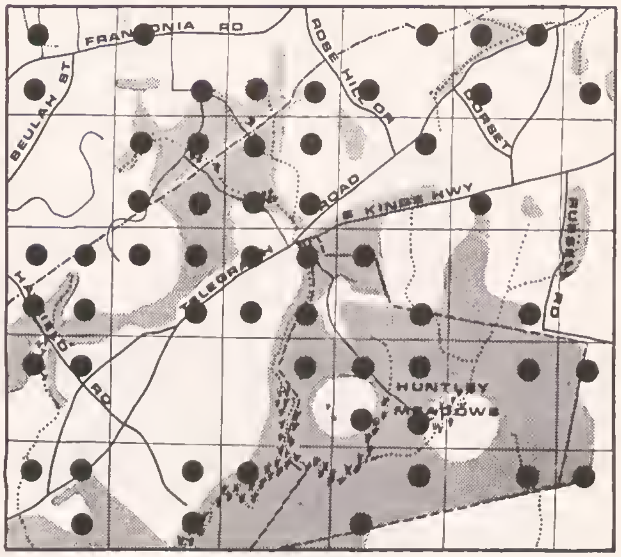

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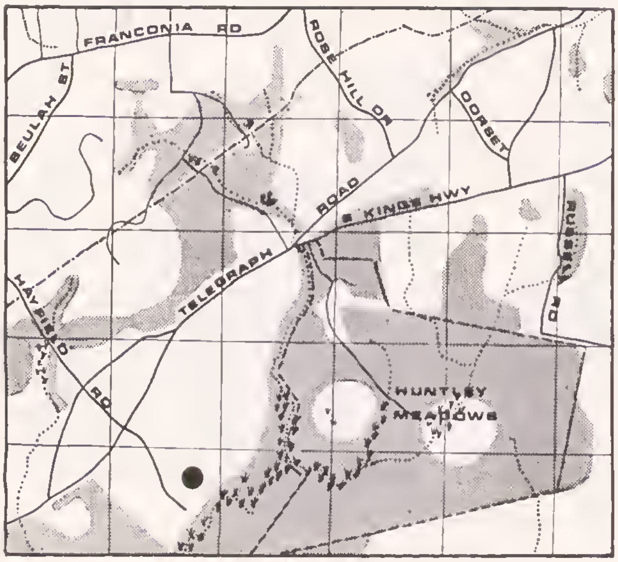

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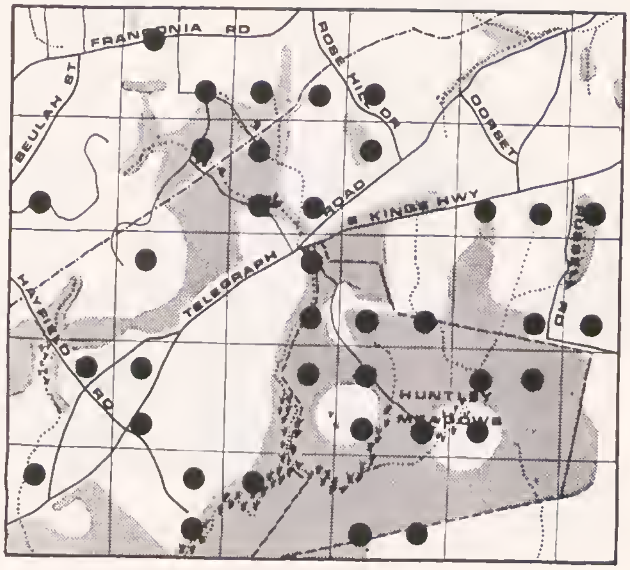

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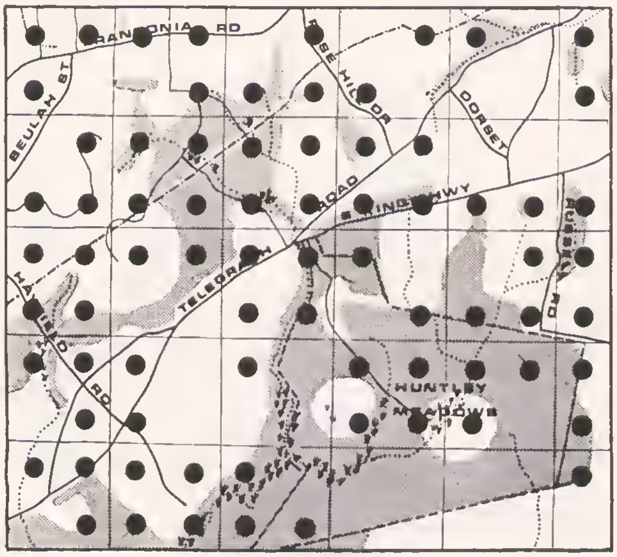
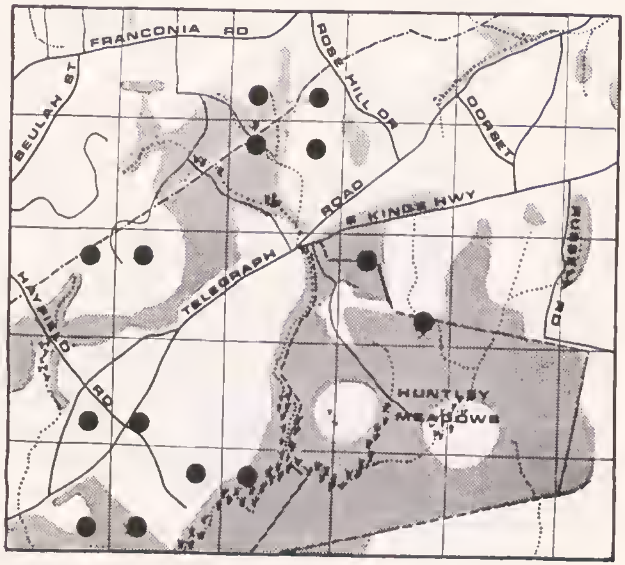


51. Silver-spotted Skipper (*Epargyreus clarus*)



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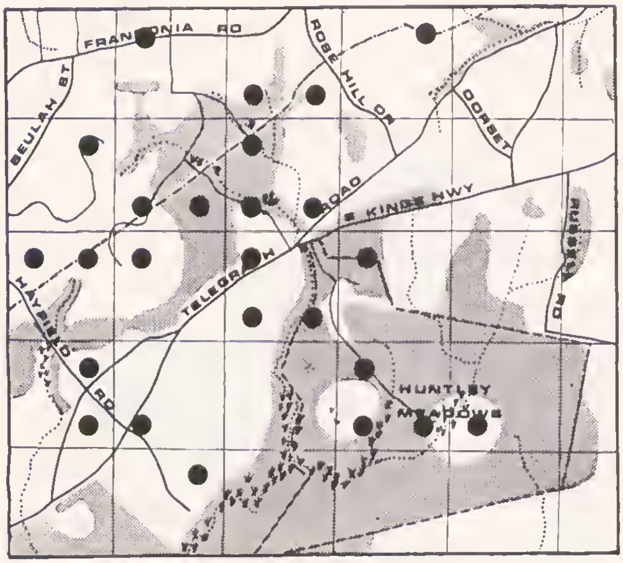
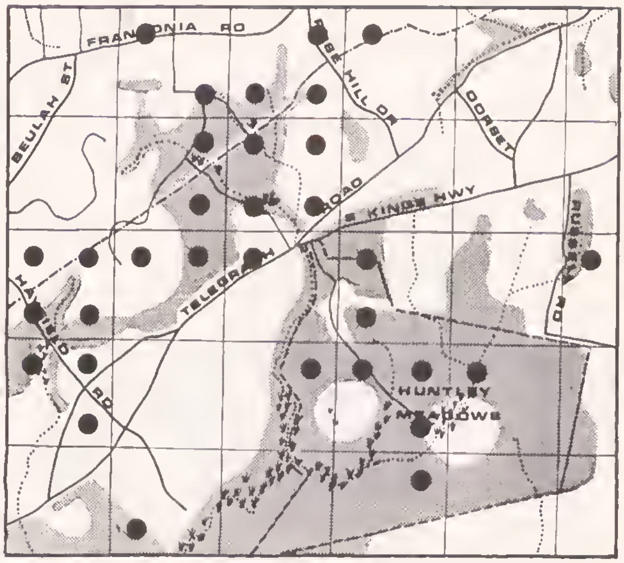


53. Southern Cloudywing (Thorybes bathyllus)



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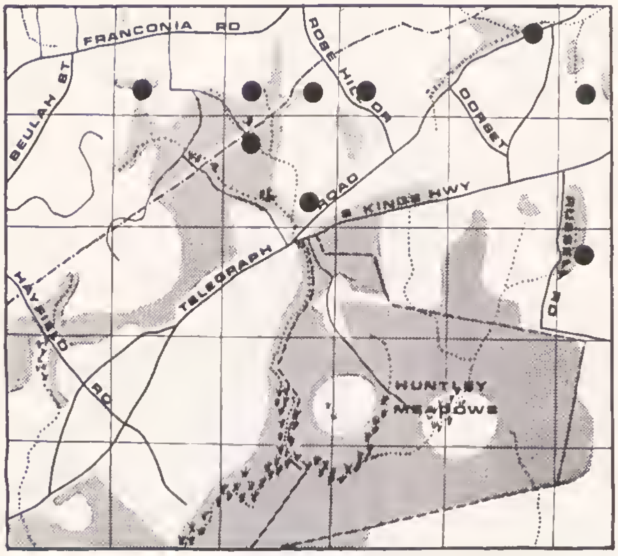
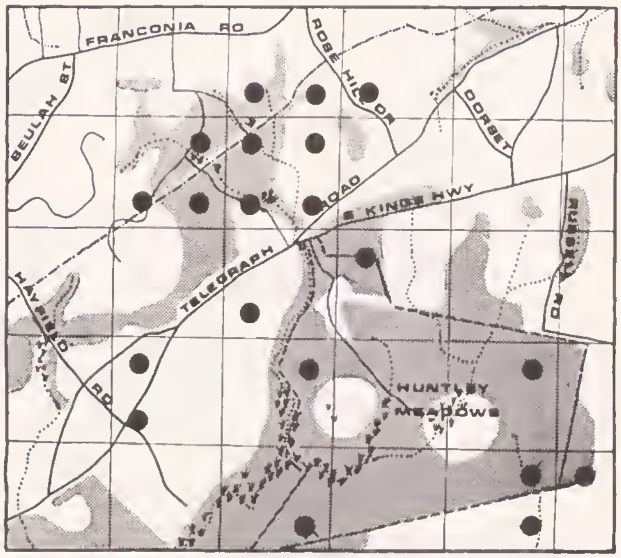


55. Southern Sootywing (Staphylus hayhursti)



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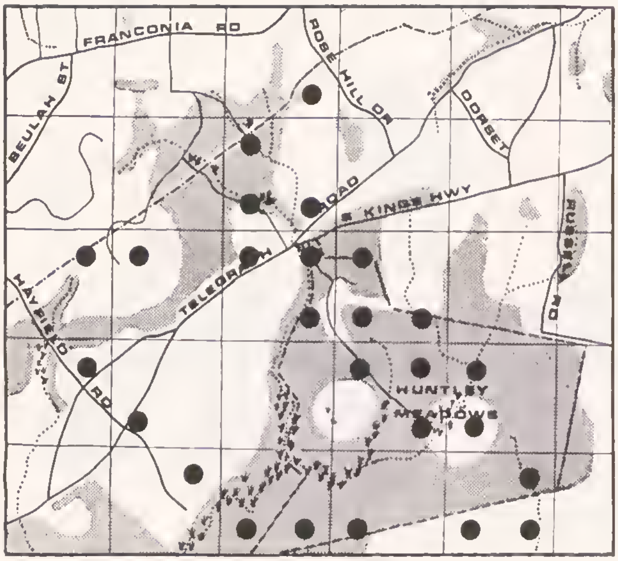

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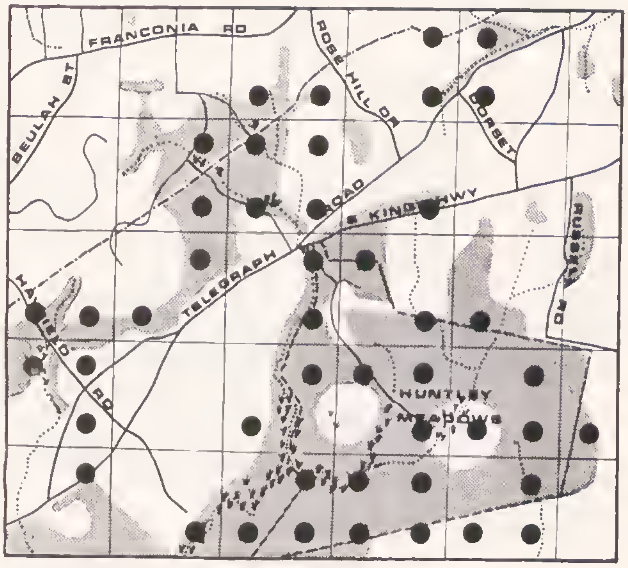

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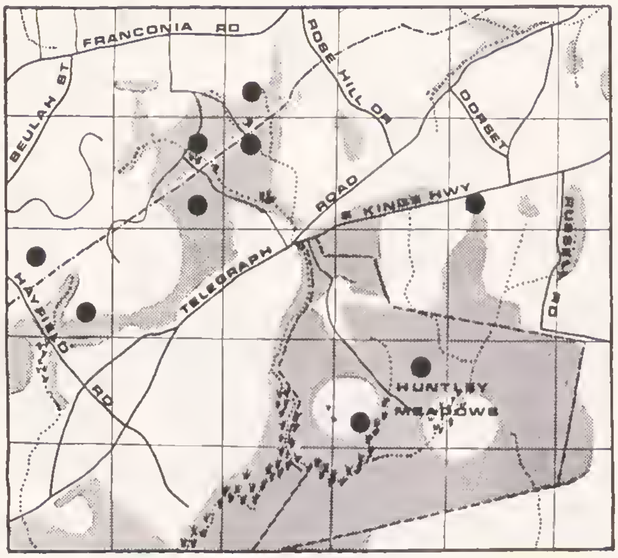

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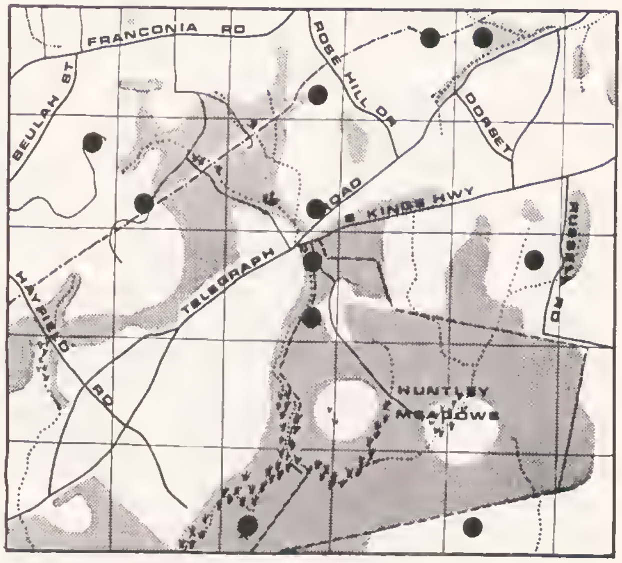
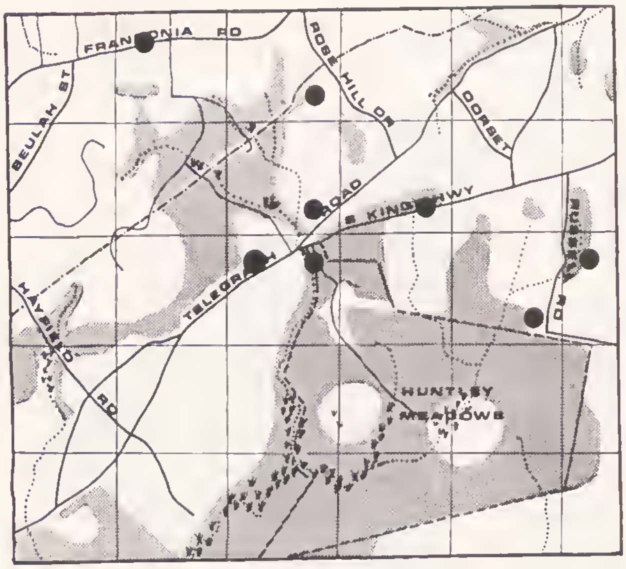


60. Checkered Skipper (Pyrgus communis)



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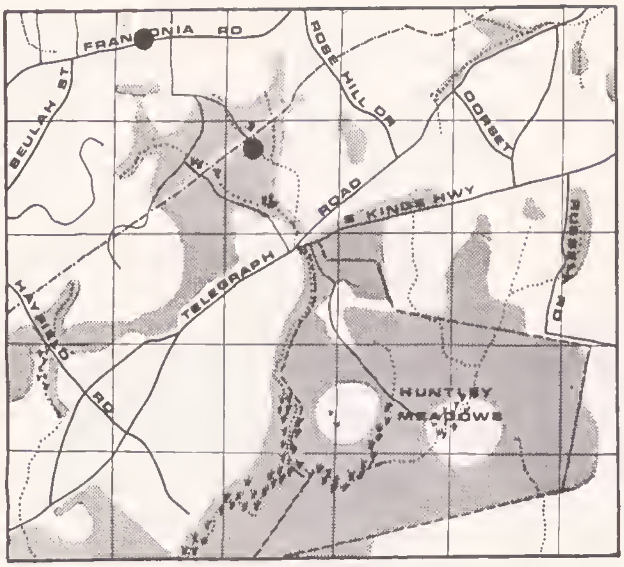

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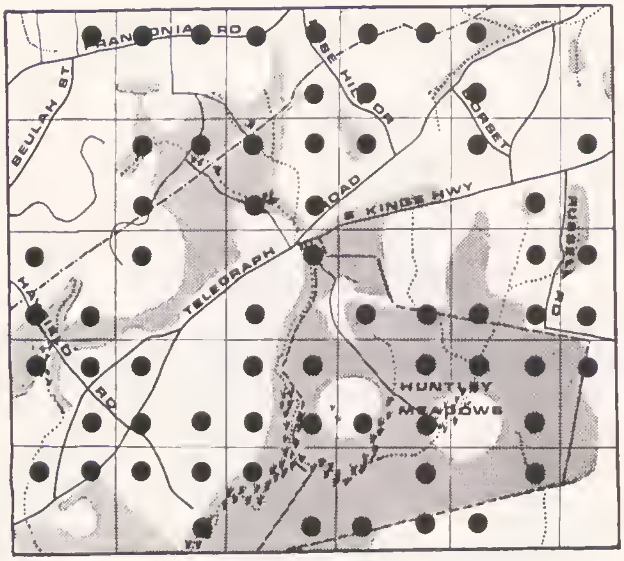
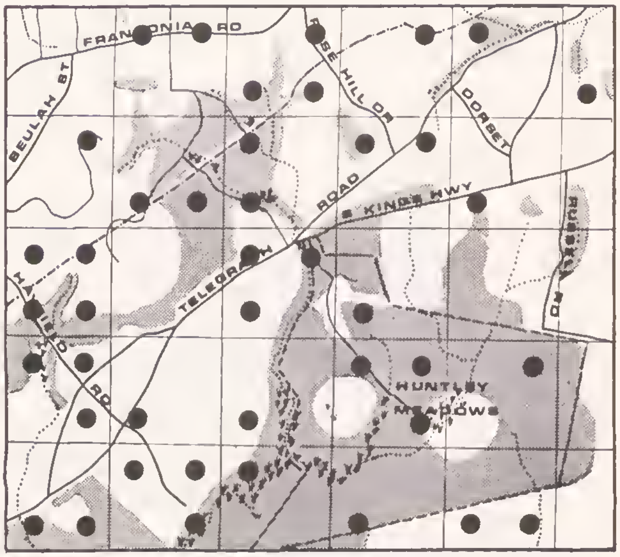


63. Least Skipperling (Ancyloxipha numitor)



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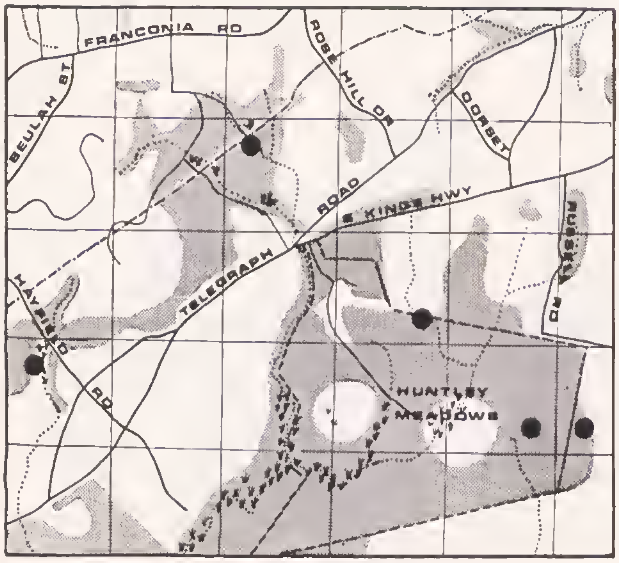

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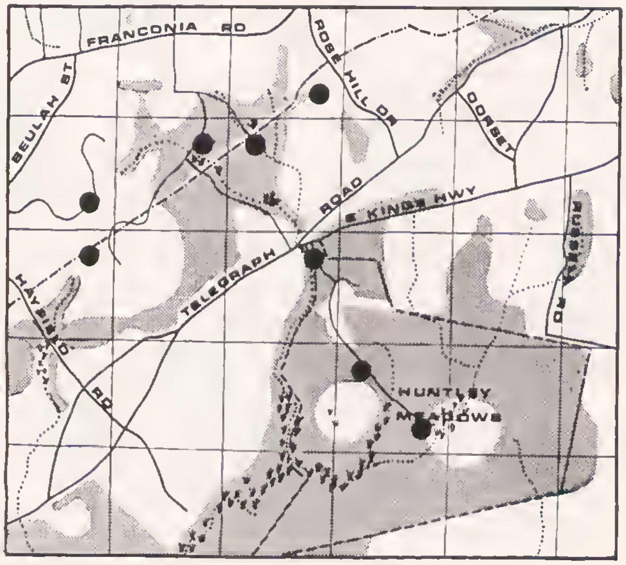

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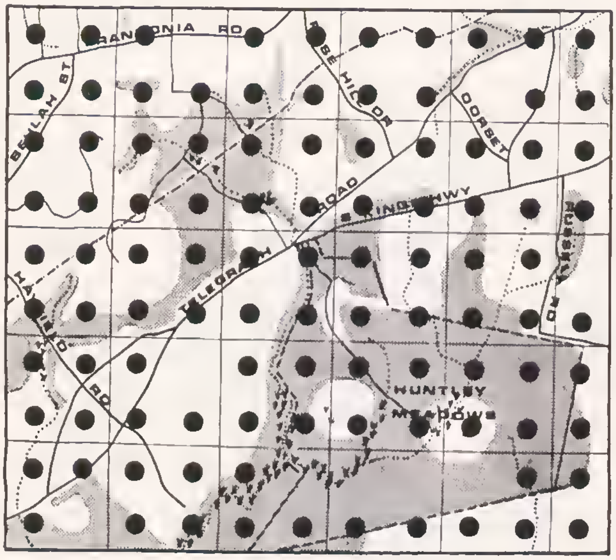
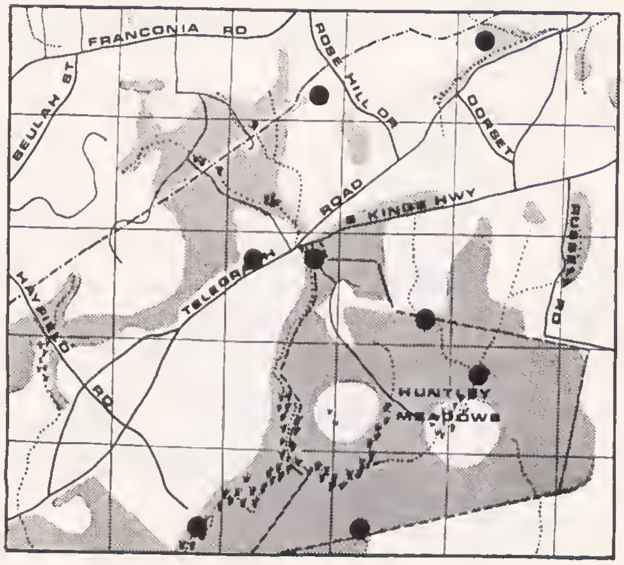
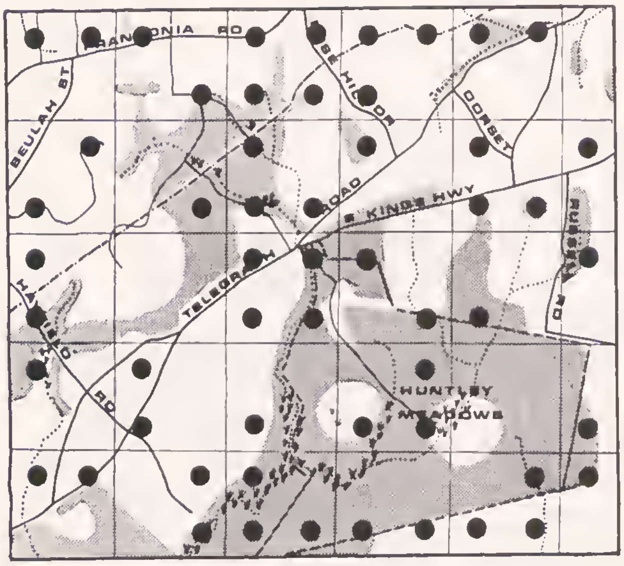


67. Satchem (Atalopedes campestris)



68. Fiery Skipper (Hylephila phyleus)



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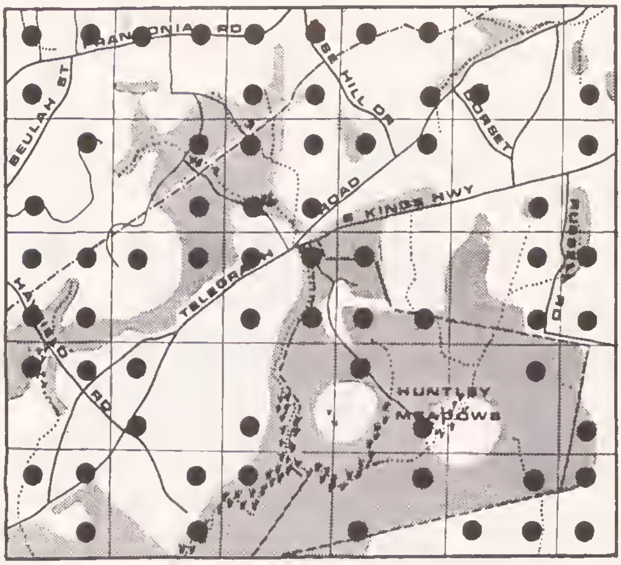

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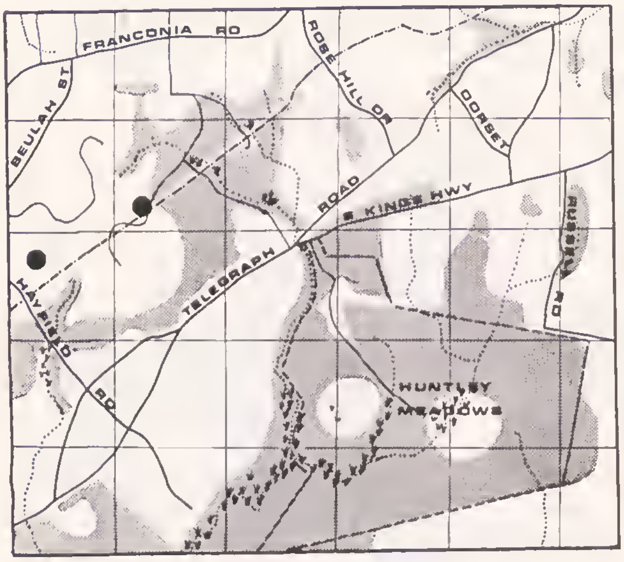

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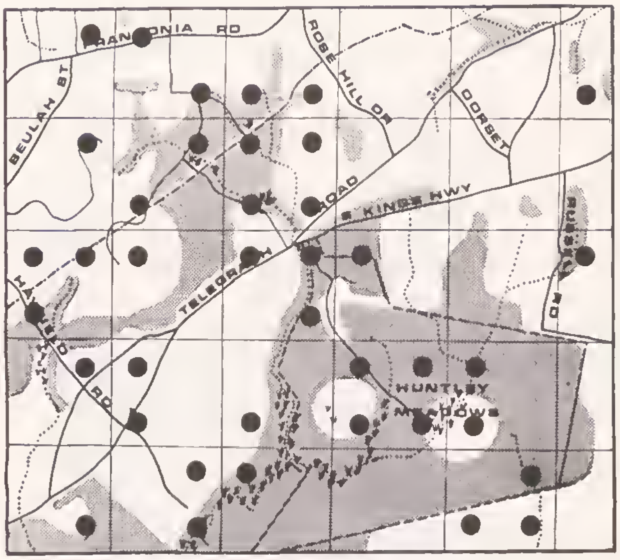

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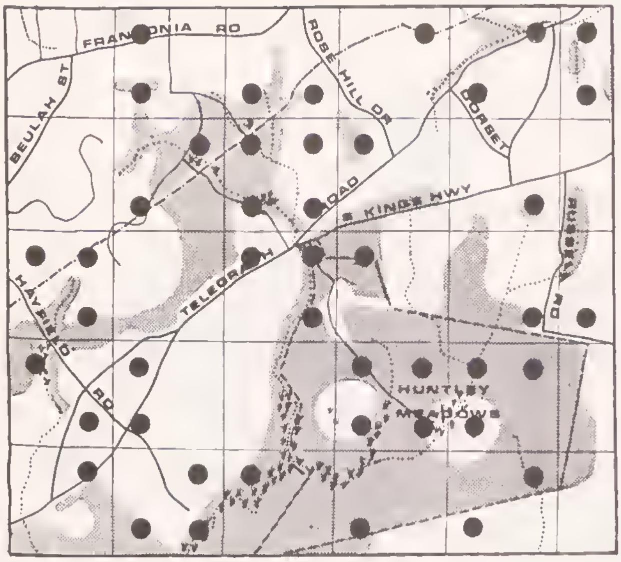

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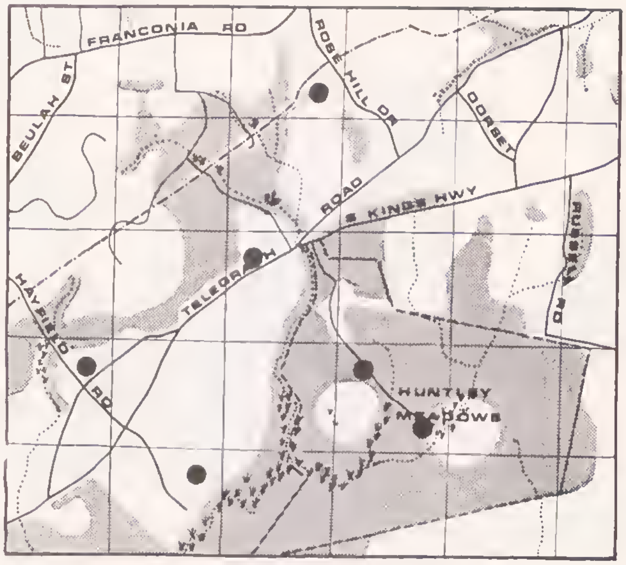

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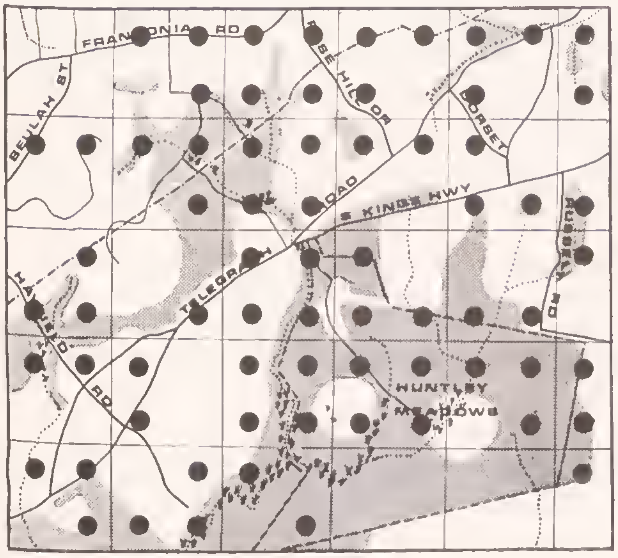

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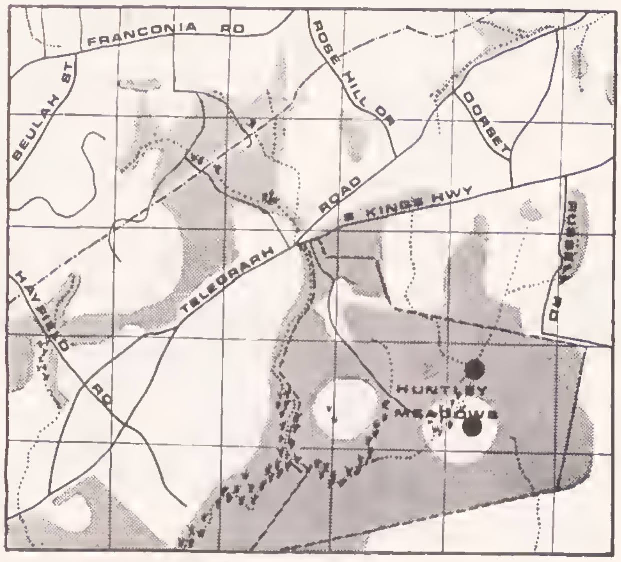

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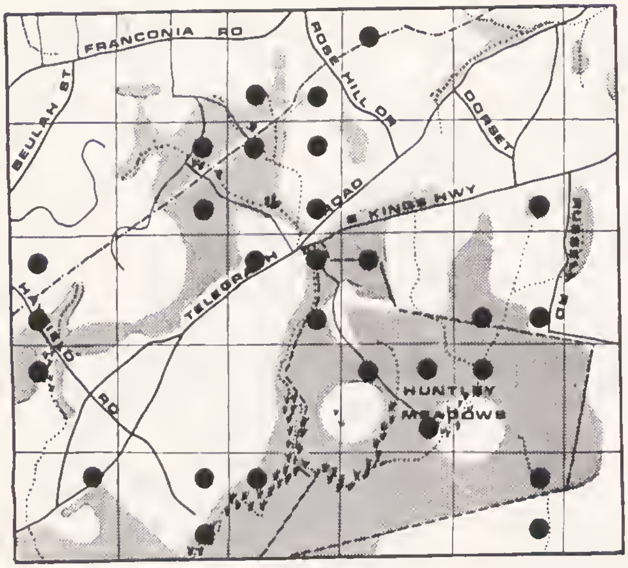

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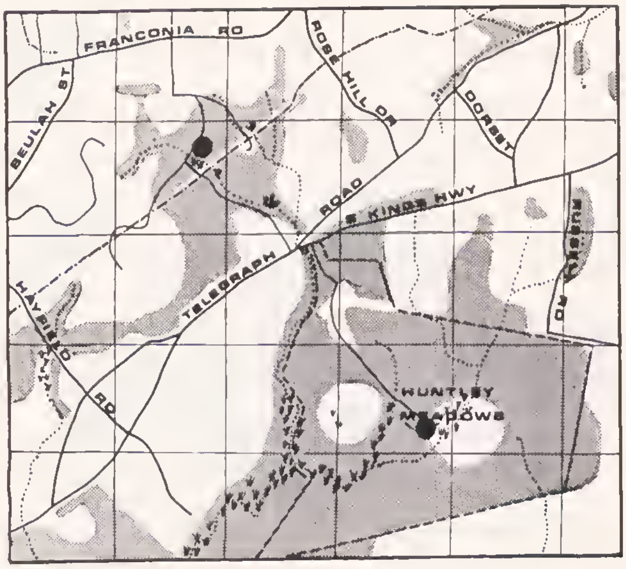

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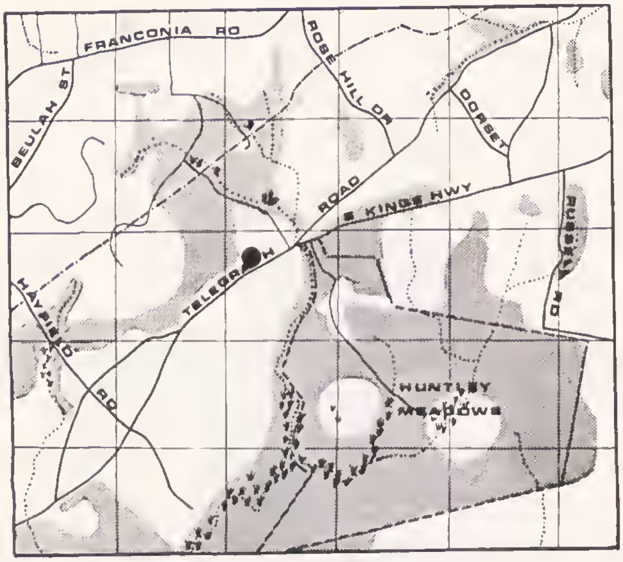

79. Ocola Skipper (Panoquina ocola)

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Formal scientific articles and notes dealing with any aspect of the ecology and conservation of invertebrates and their habitats are solicited. Articles will generally be longer papers, notes not exceeding 1000 words. Reviews of books dealing with invertebrate conservation or endangered habitats are also invited. Appropriate philosophical papers will also be welcomed.

All manuscripts should be typewritten on white, 8.5 x 11 inch, good quality bond paper, on one side only, double- or triple-spaced throughout, with margins of at least one inch on all sides. Manuscripts produced on dot matrix printers are *unacceptable* unless the printer has been set in near letter quality mode. The original manuscript and 2 copies should be submitted; authors should also retain a copy of manuscripts and figures for later consultation with the Editorial Staff.

Include illustrations and/or black and white glossy photographs as appropriate. Figures should be consecutively numbered in Arabic numerals. Hand-drawn figures should be rendered in black ink on good quality white paper, and may be larger than the final reproduced size. These and artwork will be returned after publication if accompanied by return postage. Figure captions should be typed, double- or triple-spaced on a separate sheet, and the number of the figure lightly pencilled on the back of each drawing or photograph. A map should be included as a figure with all articles dealing in a major way with a specific region or invertebrate habitat. Tables should be numbered consecutively in arabic numerals, and submitted on separate sheets in *camera-ready condition.* Cover art/photos change with each issue, and contributions will be gratefully received. Cover material should generally show invertebrates in natural settings, and prospective cover artists should consult with the Editor prior to submitting material.

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An Atlas of the Butterflies and Skippers of the Upper Dogue Creek Drainage, Fairfax County, Virginia, 1978-1982

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COVER

Collage of distribution maps for selected butterfly species occuring in the Dogue Creek Drainage, Fairfax County, Virginia. Occurence data for these maps reflect four years of intensive butterfly walks in the area. See the feature article by Paul Opler in this issue.

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